SECTION C

SPECIFICATIONS

PART 2

PROJECT SPECIFICATION
SECTION 1

GENERAL
1. PROJECT SPECIFICATION

1.1 GENERAL

1.1.1 Qatar Construction Specification

1. All work to be executed under this contract shall be carried out in accordance with the Qatar Construction Specification latest edition amplified or amended by the Project Specifications included within this section.

1.1.2 Location of the sites

1. The site of the works is located at:

Al Khor At Outskirt of Southern Doha

The boundaries thereto are indicated on the Tender Drawings.

2. The Contractor shall establish his entry and exit routes to the Site with the Engineer and shall alter these routes as and when directed.

3. The Contractor shall not use the site for any other purpose other than that of carrying out this contract.

1.1.3 Description and Scope of the Works.

1. Description

(a) The scope of construction contract works cover the Construction of Health Center at Al Khor (Package 8). The project comprises Prototype C Health Center as described below:

(b) The construction method is generally of reinforced concrete structure and block work with all associated finishes, MEP Works services and external works including paving and bitumen work, car parking and all associated soft and hard landscaping. The Works would generally include, not by way of limitations, the followings:

(i) The Mobilization,

(ii) Setting Out,

(iii) Temporary Hoarding,

(iv) Provision, equip and maintain Engineer's Representative Site Office,

(v) Excavation,

(vi) Dewatering as applicable at different locations,

(vii) Reinforced Concrete Foundation Construction, filling, slab on grade, ground beams, columns, reinforced concrete, walls, suspended slab,

(viii) Blockwork internal and external,

(ix) Plastering,

(x) Tiling,

(xi) Metal and carpentry,

(xii) Waterproofing,
(xiii) External Works,
(xiv) Paving, landscape soft and hard and all associated MEP and external works.
(xv) Handing Over, and Demobilization

2 Scope

(a) The Works shall be carried out as identified below;
(b) AL Khor Health Center:
   (i) Prototype C with an approximate area of 33,339m² consist of Basement, Ground floor, and first Floor.
(c) Ground floor & First Floor of the clinic comprises:
   (i) Men’s clinic, Women’s Clinic, Dental clinic, Walk-in clinic, Radiology, Pharmacy, Lab, Storages, Admin, 
   (ii) Chronic disease clinic, Multipurpose room, pre-marital services, staff facilities, Internal Open courtyards.
      1) Basement comprises: Public & Staff Parking ; Swimming pool in addition of Surface Parking .
      2) Ancillary Building
      3) Mosque
      4) Guard room
      5) Watchman room/waste room
   (iii) With all associated MEP and external works

1.1.4 Site Visit

1 The Contractor shall be deemed to have visited the sites before completing his Tender in order to acquaint himself fully with the project, prevailing conditions, site access and availability of services. No claim for extensions of time or additional costs shall be entertained due to the Contractor’s lack of compliance with this clause.

2 The Contractor shall make all necessary arrangements for providing safe and expeditious access to the various parts of the site and maintain, safeguard and reinstate all access works, which may be required for that purpose. All temporary access points shall be properly controlled and manned by gatemen for security purposes.

3 The Contractor shall ensure that none of the aforementioned access work (whether of a permanent or temporary nature) shall obstruct or impede services, drainage or irrigation systems.

4 The Contractor shall establish his entry and exit routes to the site with the Engineer and shall alter these routes as and when directed.

1.1.5 Proprietary Named Items

1 Proprietary named items included within this Project Specification are a guide to the quality of such items. The Contractor shall be permitted to offer other proprietary materials, which are similar and approved. However, the Contractor
shall be deemed to have priced for the items as named and not for any alternative that may be submitted later.

1.1.6 Methods Statements

1 Whenever mentioned in the Scope of Works, the Contractor shall provide a method statement for the different components of the works and for any new or repair work to the approval of the Engineer. All costs associated with the preparation, submission and approval of these method statements shall be included in the tender price.

1.1.7 Materials from AGCC States

1 Notwithstanding Section 1, Part 9, Item 9.1.2 of QCS, wherever possible and insofar as the same conforms to the standards required by this Specification, all materials, goods etc., shall be obtained from local (Qatar based) manufacturers and producers.

1.1.8 The Contract Price shall be fully inclusive

1 The Contractor shall be deemed to have included in the Contract Price for everything essential for the proper completion of the works whether or not shown on the drawings or included in the Specifications.

1.1.9 Samples and Sample Panels (QCS 1-9.1.6)

1 Further to the requirement of Section 1- Part 9, Item 9.1.2 of QCS the Contractor shall submit samples, sample panels and manufacturer's literature in respect of all materials, products and equipment required for the Works, before ordering or use, for the approval of the Engineer. The provision of all samples and sample panels shall be at the Contractor's own expense.

2 The Contractor at his own cost shall engage a third party QA/QC bodies and/or testing agency to perform all tests.

3 The costs of all tests necessary to ensure compliance with the contract documentation, including the cost of delivery to the testing laboratory off-site, shall be borne by the Contractor. Such tests shall be undertaken by third party QA/QC bodies and/or testing agencies, as specified for quality control testing and/or third party inspections, the services of which are to be engaged by the Contractor at his own costs.

4 The Costs for performing testing, retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to the Contractor.

5 The Contractor shall submit a certified written report, in duplicate, of each quality-control service.

1.1.10 Delivery and Storage of Materials (QCS 1-9.2 and 9.4)

1 Checking compliance of products and materials: The Contractor shall check all delivery tickets, labels, identification marks and where appropriate, the goods themselves to ensure that all products comply with the Specification. Where different types of any product are specified, he shall ensure that the correct type
is being used in each location. In particular, the following shall be checked:

2 Protection of products and materials.

3 The Contractor shall:

   (a) Prevent over-stressing and any other type of physical damage.

   (b) Keep clean and free from contamination and staining.

   (c) Keep dry and in a suitably low humidity atmosphere to prevent premature setting, moisture movement and similar defects. Where appropriate, allow free air movement around and between stored components.

   (d) Prevent excessively high or low temperatures and rapid changes of temperature in the material.

   (e) Protect adequately from rain, sun and other elements as appropriate.

   (f) Keep different types and grades of materials separate and adequately identified.

   (g) So far as possible, keep materials in their original wrappings, packing or containers, with unbroken seals, until immediately before they are used.

1.1.11 Protection (QCS 1-9.2.5)

1 Security: The Contractor shall take all measures necessary, including watching and lighting at night, to prevent unauthorised entry to the Site and to safeguard the Site, the Works, materials, Plant, Contractor’s Equipment and Temporary Works against damage from trespass and theft.

2 Protection: The Contractor shall cover up and protect each section of completed work from damage by water, extreme heat and inclement weather or from damage caused by later operations and shall make good any damage to the satisfaction of the Engineer.

3 Stability: The Contractor shall ensure that stability and structural integrity of the Works are maintained during construction and shall provide temporary supports where necessary and shall not overload any part of the Works with materials, Plant or Contractor’s Equipment.

4 Moisture: The Contractor shall prevent any part of the Works from becoming wet or damp where this may cause damage and shall provide fuel, equipment and attendance as necessary to dry out the Works in such a manner as to prevent blistering and failure of adhesion, damage due to entrapped moisture or excessive movement.

5 The Contractor shall take all measures to prevent the works from becoming infested by rodents or insects.

1.1.12 Contractor’s Temporary Buildings (QCS 1-12.2)

1 The Contractor shall maintain an office at the Site to the approval of the Engineer, such office shall be maintained and kept open throughout the whole period of the Works to receive instructions and other communications, until the Works shall have been completed.

2 The Contractor shall provide suitable storage sheds and fenced compounds to
safeguard all materials and plant delivered to site and to protect from damage by weather or other adverse conditions all materials and goods that are liable to damage.

3 The Contractor shall provide workshops and equipment for the manufacture and or assembly of work on site

4 All latrines and other similar facilities shall be connected to the permanent drainage system if available. Use of Earth closets, chemical closets or sewage holding tanks will be subject to Engineers Approval

1.1.13 Engineer Site Facilities – (QCS-1-11.2)

The Contractor shall proceed with the provision of the portable offices, which shall be for the exclusive use of the Engineer/Consultant immediately following the award of the Contract and shall provide temporary alternative accommodation to the to the Engineer’s approval until such time as the offices are made available (refer to QCS 2014 11.3.3.5 & 11.2.3.6 & 11.3.3.7 & 11.3.3.8 & 11.3.3.9 & 11.3.3.10 & 11.3.3.11)

1 Engineer Site Offices

(a) – 1 No. office 4 x 9 m
(b) + 1 No toilet 1.6 x 2.2 m
(c) - 2 Nos. offices 4 x 4 m
(d) - Pantry 2 x 4 m
(e) - 1 No Toilet 1.6 x 2.2 m

2 Consultant’s Offices

(a) Consultant’s Site Office
   (i) - 1 No. office 4 x 9 m
   (ii) +1 No. toilet 1.6 x 2.2 m
   (iii) - 5 Nos. offices 4 x 4 m
   (iv) - 2 Nos. toilet 1.6 x 2.2 m
   (v) -1 No. Secretary room 4 x 4 m
   (vi) - 1 No. archive room 4 x 4 m
   (vii) - 1 No. site sample room 4 x 9 m

(b) Each office 4 x 9 m shall be provided with the following furniture to the approval of the Engineer:
   (i) 1 No. kneehole pattern desk with a total of six lockable drawers and approximately 1500 x 800 x 760 mm in size.
   (ii) 1 No. swivel chair with armrests.
   (iii) 2 Nos. chairs with armrests.
   (iv) 1 No. round meeting table with 8 chairs with armrests.
   (v) 1 No. hanging file or plan chest suitable for A0 size prints.
   (vi) 1 No. wastepaper basket.
   (vii) 1 No. two drawer filing cabinet.
   (viii) 1 No. wall mounted pin board, 1000 x 3000 mm in size.

(c) Each site office shall be provided with the following furniture to the approval of the Engineer:
   (i) 2 Nos. kneehole pattern desks with a total of six lockable drawers and approximately 1500 x 800 x 760 mm in size.
(ii) 2 Nos. swivel chairs with armrests.
(iii) 2 Nos. chairs with armrests.
(iv) 1 No. hanging file or plan chest suitable for A0 size prints.
(v) 1 No. wastepaper basket.
(vi) 2 Nos. two drawer filing cabinet.
(vii) 1 No. wall mounted pin board, 1000 x 2000 mm in size.

(d) Each toilet shall be provided with the following sanitary fittings to the approval of the Engineer and an adequate supply of hot and cold water at all times:

(i) 1 No. low level WC suite.
(ii) 1 No. Wash-hand basin.
(iii) 1 No. shower tray, mixer fittings, rose and shower curtain.
(iv) 1 No. toilet roll holder, towel rail, soap dish and mirror.
(v) A suitable number of cups, saucers and drinking glasses.

(e) The meeting room shall be provided with the following furniture to the approval of the Engineer:

(i) 1 No. conference table for 16 persons.
(ii) 16 Nos. swivel chairs with armrest.
(iii) 1 No. wall mounted white board 1000 x 2000 mm in size.
(iv) 1 No. wall mounted pin board, 1000 x 3000 mm in size.
(v) 1 No. hanging file or plan chest suitable for A0 size prints.

(f) The archive and samples room shall be provided with Shelf units for documents and approved samples with 5 tiers of shelves 400 mm wide x 2400 mm long overall, to the approval of the Engineer:

(g) Each Kitchen/Pantry shall be provided with the following equipment to the approval of the Engineer:

(i) 1 No. stainless steel single bowl single drainer sink with hot and cold water and cupboards underneath.
(ii) 1 no. floor mounted two door cupboards to match sink.
(iii) Cabinets and shelves to match sink, as required.
(iv) 2 ring cooker and microwave.
(v) 1 No. Refrigerator/Freezer with a capacity no less than 500 litres.
(vi) 1 No. three pint kettle and sufficient crockery and cutlery.
(vii) A suitable number of mugs, cups, saucers, and drinking glasses.
(viii) Table coasters for use on desk tops.
(ix) Hand towels and drying up cloths, laundered regularly.
(x) Dishwashing facilities, clothes, sponges and washing up liquid, all replaceable.
(xi) Cleaning brushes, mop, bucket and floor clothes.

(h) The Contractor shall insure the site offices against fire, burglary and other risks.

(i) The Contractor shall keep on site at all times an adequate supply of clean, fresh, chilled drinking water for the consumption of the .

(j) The Contractor shall maintain the offices in a clean and sanitary condition.

(k) All furniture and equipment shall remain the property of the Contractor and shall be removed following completion of the works.

3 Telephones and facsimile Machines

(a) The Contractor shall supply and install a telephone in each office and the meeting room. Each Telephone shall be connected to a private address
box exchange (PABX) system. The Contractor shall also supply and install a facsimile machine. The telephones, PABX system and Facsimile system shall conform to the relevant provisions of any Telecom Provider standard or requirement (refer to QCS 2014 11.4.7.3 & 11.4.7.4 & 11.4.7.5)

4 Attendance

(a) Assistance to the Engineer/Consultant

(i) The Contractor shall provide assistance to the Engineer/Consultant in carrying out his duties.

(ii) The Contractor shall provide for the use of the Engineer’s/Consultant’s Representative and his staff, any chainman/assistants to carry out any duties whatsoever, as required by the Engineer’s Consultant’s Representative.

(b) Contract Administration

(i) The Contractor shall provide secretaries, cleaners and tea person for the exclusive use of the Engineer/Consultant for the duration of the Contract.

5 Internet Facilities (QCS 2014 1-11.3.5)

(a) The Contractor shall provide ADSL internet connection at each office for the use of the Engineer/Consultant only.

(b) The contractor shall provide Q-Tel ground services line for providing telephone line and in case of non-availability of Q-tel ground services, the contractor shall provide alternative such as GSM line on his cost for the exclusive use of the.

6 Photocopier

(a) The Contractor shall provide a new two photocopiers for the sole use of the Engineer/Consultant. The performance specification for the photocopier shall be as detailed in the project documentation (refer to QCS 2014 11.4.3.2, 11.4.3.3, 11.4.3.4, 11.4.3.5, 11.4.3.6, 11.4.3.7, 11.4.3.8, 11.4.3.9, 11.4.3.10).

7 Car parking facilities (QCS1-11.2.4)

Parking areas shall be paved or have a finished surface as approved by the Engineer and shall be covered with a suitable canopy to provide shading, for a minimum of 20 cars.

8 Utility Connections

(a) General

(i) The Contractor shall make all arrangements and pay all charges in connection with the installation, maintenance, operation and removal of the service utilities described in this clause

(b) Electricity

(i) The Contractor shall arrange for the provision of an uninterrupted electrical power supply to the Engineer’s/Consultant’s offices during
all working hours and any at other time as requested by the Engineer/Consultant for the duration of the Contract.

(c) Water
(i) The Contractor shall arrange for the provision of an uninterrupted water supply to the Engineer’s/Consultant’s offices during all working hours and at any other time as requested by the Engineer/Consultant for the duration of the Contract.

(ii) The Contractor shall provide inline filters on all water supplies into Employer and Engineer’s Consultant’s site facilities. The Contractor shall maintain these at regular intervals as per manufacturer instruction throughout the duration of the work order.

9 Telephone (QCS 2014 1-11.3.4)

(a) The Contractor shall provide telephone lines for the sole use of Engineer/Consultant.

(b) The Contractor shall make all arrangements and pay the fees in connection with the installation and call charges due or occurred during the Contract period only

10 Provision of Equipment and Supplies

(a) The following items of equipment, supplies and associated level of services shall be provided as follows:

(i) Computers, Scanners & Printers

1) The Contractor shall provide new computers and printers with all consumables necessary for its operation, for the sole use of the engineer as per the following specification:

a) Intel Pentium IV Processor 2.8 GHz

b) 8GB DDR3 RAM, 250 GB Hard Disc (10 Krpm), 768 MB dedicated NVIDIA FX1800 or higher; 1 Gbps LAN connection

c) DVD - ROM + Soundcard (Full Duplex)

d) 3 COM/XIRACOM10/100 LAN CARD

e) 56 KB Fax Modem

f) Software: Original, latest Arabic/English version, multi-user licensed copies of the following software programs for specified operating system, together with user manuals:

i) "Microsoft Professional Office", including 'Word', 'Excel', 'Power Point', 'Access' and 'Outlook'.

ii) "Microsoft Internet Explorer".

iii) "Primavera Project Planner".

iv) "AutoDesk AutoCAD".

v) "Norton AntiVirus".

g) Internet: Multi-user subscription and connection to approved, local, Internet service provider.
h) LaserJet Printers: A4 Size B&W, Xerox 3600DN or similar (one unit for each Site – total 2 units)

i) Multifunction Printers: A3 Size Colored, Xerox 8560MFP/D or similar (one unit for each Site – total 2 units)

(ii) The Contractor shall maintain the computers and printers for the duration of the Contract only.

1.1.14 Measuring and Recording Equipment (QCS 1-11.4.4)

1 Surveying Equipment and Assistance: Make available on site suitable surveying equipment to the Engineer's requirements, in good condition, to enable the Engineer's Representative to check setting out etc. Provide chainmen and other assistants if required.

2 Thermometers: Provide on Site: maximum and minimum thermometer for measurement of atmospheric temperature thermometer for measurement of concrete and ground temperature.

3 Test Equipment: Make available to the Engineer's Representative all test equipment required for carrying out tests on materials or finished work required by the Specification.

4 Inspection facilities: Provide all ladders, access, lighting, and other facilities and assistance required by the Engineer's Representative to inspect any part of the Works.

1.1.15 Temporary Site Hoarding, Fans, Screens Etc (QCS 1-4.5.1)

1 The Contractor is to provide site hoarding, screens, etc., to the standard described in QCS Section 1.Part 4.5, including all necessary maintaining, adaptation and removal upon completion.

2 Elsewhere the Contractor shall provide all requisite safety and security measures including temporary screens, barriers, guardrails and the like and shall alter and adapt as necessary as the construction of the works progresses.

3 All temporary site hoardings, screens, barriers, guardrails and the like shall be to the prior approval of the Engineer.

4 The Contractor's attention is also drawn to his obligations and responsibilities in respect of QCS Section 1-Part 4, Item 4.4, Watching and Lighting.

5 The Contractor shall provide a pattern / logo as directed by the Engineer.

1.1.16 Name Boards and Advertising (QCS 1-12.3 and 12.4)

1 The Contractor shall erect and dismantle and remove on completion of the works a temporary name board written in Arabic and English and shall have the following:

   (a) Name of Project and its purpose.
   (b) Name of client: as advised by Engineer
   (c) Name of Consulting Offices
   (d) Name of Main Contractor

2 Size of board perspective view drawing to be obtained from the Consultant/Client.

1.1.17 Contractor's Progress Report (QCS 1-7.8)

1 Special Records: In the event of delays for which an extension of time for
completion is sought under Clause 44, or in the event of any claim for costs, the Contractor shall keep such special records of the circumstances as the Engineer's Representative may require, and submit copies regularly for his inspection.

2 Photographs: In addition to the Contractors report, provide progress photographs taken from ten approved stations on the site at monthly intervals and submit 3 prints not less than 20 cm x 25 cm of each negative.

1.1.18 Restriction to the Use of the Site

1 All access ways shall be cleaned regularly and washed down with water and any damage caused to the existing roadways shall be repaired immediately to match the surrounding finishes entirely at the Contractor’s own cost.
2 Any damage caused to existing structures, existing building fabric/ components / finishes of whatsoever nature, existing services and existing hard and soft landscaping as a result of carrying out the works shall be repaired immediately to match existing to the entire satisfaction of the Engineer and entirely at the Contractor’s own cost.
3 The Contractor should note that photography on the site and in the areas surrounding the site is strictly forbidden.
4 The Contractor shall allow for any other contractor’s access, Services Authorities access, and security checks authorized by the Employer. All costs in connection with such access shall be deemed to be included in the tender price.

1.1.19 Temporary Roads (QCS 1- 3.21)

1 The Contractor shall be required to maintain and provide satisfactory temporary access and traffic flow to and from and within the areas of the Works. Temporary traffic signs and lighting for temporary roads and diversions are to be strict accordance with the requirements of the Qatar Traffic manual and any additional requirements instructed by the Traffic Police or the Engineer. Details of proposals for any such temporary measures are to be submitted by the Contractor for approval by the Traffic Police and the Engineer unless otherwise instructed. Such approval shall not relieve the Contractor of any of his duties or responsibilities under the Contract.
2 The Contractor shall maintain at all times pedestrian access to all properties fronting the roads affected by the Works.
1.1.20 Maintenance of Roads (QCS 1-4.3.1)

1 The Contractor will be held responsible for any damage caused by him, his work people, Sub-Contractors or Suppliers to public or private roads, paved areas paths verges, trees, shrubs, fences, boundary walls, gates, signs, drains, ducts and services during the execution of the Contract and shall bear the cost of making good any damage to the entire satisfaction of the local and other authorities and owners. The Contractor shall keep all private roads and paths clean and free from dirt and debris and any obstruction associated with the Works, which would prejudice the safe and unimpeded normal use of the said roads and paths.

1.1.21 Security Requirements (QCS 1-10.6.1)

1 The Contractor shall allow for complying with any current security regulations and requirements, which may be applicable to the site. The Contractor will be deemed to have acquainted himself thoroughly with all security regulations that may be in force at the time of submission of tender and to have allowed in his tender for their effect upon his operations with regard to the supply of labour and materials, access to site and project execution generally. No claim will be entertained for the Contractor’s lack of knowledge of security regulations. The Contractor shall ensure that his workforce and staff on site adhere strictly to cultural restrictions.

2 The Contractor shall ensure that his workforce, staff and visitors on site adhere strictly to cultural restrictions.

3 The cost of any delay resulting from the security requirements and regulations will deemed to be included in the tender price.

4 The Contractor shall ensure that his Workmen remain in the work area assigned to them at any given time. Any breach of this requirement shall render the worker(s) liable for instant and permanent removal from all areas of the site.

1.1.22 Restriction of Working Hours

1 The Contractor shall be only permitted to work from 6.00 am to 6.00 pm. Extended hours will be permitted only with the Engineer’s authorization. Noise is to be kept to a minimum.

1.1.23 Programme (QCS 1-7.4)

1 The Contractor shall provide a computer-based programme in critical path network form, showing at least the following information:

(a) Contract milestones (Engineer’s order to commence, Commencement Date, date for completion of sections of the Works, date for completion of the whole of the Works etc.)

(b) Durations and earliest/latest start and completion dates for each construction activity

(c) Float time for each activity.

(d) Total float time.

(e) Dates and times for procurement of materials and plant.

(f) Dates and times for performance of work by Subcontractors

(g) Dates for supply by the Engineer of drawings and other information.

(h) Dates for submission by the Contractor of shop drawings, samples and the
like and dates for approval by the Engineer

(i) Dates and times for work to be performed by other contractors or for materials and plant to be supplied by the Employer.

(j) Dates and times for testing and commissioning plant and engineering installations.

2 Resource Schedules: The computer program used for preparing the programme shall also be used for preparation of resource schedules to be submitted to the Engineer with the programme. The resource schedules shall show at least the following information:

(a) Numbers and classes of workmen to be employed on the Site for each activity.

(b) Materials to be used for each activity.

(c) Contractor’s Equipment and Temporary Works to be supplied or constructed and the dates for supply, construction and removal.

3 Cash Flow Estimate: Contractor shall prepare a cash flow estimate, using the computer programme, for submission to the Engineer.

4 Monitoring: The Contractor shall monitor progress of the works and the supply of resources and cash flow compared with the programme, schedules and estimate and shall revise the programme, schedules and estimate as required by Conditions of Contract Clause 14. Copies of revised programmes etc. and notices of actual and forecast delays and shortfalls shall be regularly given to the Engineer.

1.1.24 Cleaning the Works (QCS 1-20)

1 Further to the requirements of Section 1- Part 20 of QCS and Conditions of Contract Clause 33 (3), the Contractor shall clear the site and any buildings thereon of all materials, plant, rubbish and building debris of any nature to a tip designated by the relevant Municipality for the area and shall ensure that the area surrounding the Works is clean and to the natural level of the surrounding land.

2 If the Contractor fails to comply with the foregoing requirement within 30 days of Practical Completion of the Works the Engineer may, in addition to the terms of the Conditions of Contract:

(a) Clear the site using another contractor and deduct the costs so incurred from any monies due to the Contractor, and

(b) Delay final payment to the Contractor until such time as the Site has been cleared to the satisfaction of the Engineer and relevant municipality.

1.1.25 Drawings to Be Provided By the Contractor

1 General: The Engineer will supplement the Contract Drawings with further drawings issued in accordance with Clause 8 of the Conditions of Contract as he deems necessary. The Contractor shall prepare all other drawings required for Temporary Works and for fabrication and co-ordination of trades and prepare all shop drawings and other drawings and documents required under the contract.

2 Design and Shop Drawings: Prepare and submit for approval, specifications, calculations, manufacturers’ data etc. as required by the Specification or instructed by the Engineer in good time to meet the programme (including an
allowance of 15 days for Engineer's approval and extra time for resubmission in the case of rejection) and, in any case, a minimum of 45 days before the work is to be commenced or order placed, as appropriate. Carefully check drawings before submission to ensure that no conflict exists with other parts of the work.

3 Supporting data, such as manufacturers' standard details, performance standards etc., are to be in English, or accompanied by a translation, and are to be properly referenced to the Drawings and Specifications.

4 Procedure for submission and approval:

(a) Submit two copies of drawings and other documents for approval to the Engineer.
(b) Within 15 days of receipt at the Engineer's design office, the Engineer will return one copy of the drawings stamped as:
   (i) approved, or
   (ii) Approved subject to amendments shown on the returned copy or in an accompanying letter, or
   (iii) Rejected, with recommendations for resubmission
(c) In the case of approval, work may be commenced or orders placed
(d) In the case of approval with qualifications, work may be commenced or orders placed, at the Contractor's risk; providing the qualifications are implemented. Submit revised drawings for approval.
(e) In case of rejection, resubmit until approval is obtained.
(f) Provide four copies, and reproducible copy if required, of all approved material

1.1.26 As Built Record Drawings (QCS 1-7.10.2)

1 The Contractor shall prepare As-Built Record Drawings and submit them to the Engineer for approval. Upon approval, the Contractor shall submit a further four (4) copies of each As-Built Record Drawing to the Engineer. All As-Built record Drawings shall be prepared on clear white polyester film or other durable and easily reproducible medium approved by the Engineer.

1.1.27 Site Administration (1-6.3)

1 Contractor's Site Meetings: The Contractor shall hold such meetings as are necessary for co-ordination of subcontractors and review of progress.
2 Co-ordination of Subcontractors etc.: The Contractor shall co-ordinate the work of all trades and subcontractors so as to avoid delay and disruption or abortive work. The Contractor shall provide all drawings, dimensions and other information required for the proper execution of subcontract works and of associated builder's work, and shall accept responsibility for the accuracy and fitness of subcontract works.

1.1.28 Statutory and Other Obligations

1 Noise, Pollution and Nuisance: The Contractor shall ascertain and comply with any regulations concerning noise, pollution and other nuisance in addition to the obligations imposed by the Conditions of Contract and by law.
2 Noise: Compressors, percussion tools and vehicles are to have effective silencers of a type recommended by the manufacturers of the equipment. Pneumatic drills and other noisy appliances shall not be used during days of rest
3 Nuisance: The Contractor shall take necessary precautions to prevent nuisance from smoke, dust, rubbish, water, polluted effluent and other causes.

4 Explosives are not to be used. Rock excavation is to be carried out by the use of jack hammers or other approved methods.

1.1.29 Protection of Other Property and Services

1 Roads and Footpaths: The Contractor shall protect public and private roads, footpaths and the like from damage by site traffic or other causes arising from the execution of the Works and shall repair any damage to the satisfaction of the relevant public authority or private owner.

2 Existing Features: The Contractor shall prevent damage to existing buildings, fences, gates, walls, roads, paved areas and other features on the Site or adjacent thereto which are to remain in position during the execution of the Works.

3 Existing Services: The Contractor shall:

(a) Notify all service authorities and private owners before commencing any work, which may affect or damage existing drains and services and observe all service authorities' regulations and/or recommendations for work adjacent to existing services.

(b) Ascertain the positions of all services not indicated in the Contract Documents and check the positions of those, which are so indicated.

(c) Adequately protect, maintain and prevent damage to all services and shall not interfere with their operation without the consent of the service authority or owner.

(d) If any damage is caused to existing services as a result of execution of the Works, the Contractor shall notify the Engineer's Representative and the service authority or private owner and make arrangements to repair the damage to the satisfaction of the service authority or private owner as appropriate.

4 Existing condition of roads, paths, features, services and adjoining property, which is at risk from damage, shall be recorded by photographs or surveys as appropriate.

1.1.30 Setting Out and Accuracy

1 Site Survey: Before commencing work on Site, the Contractor shall carry out a topographical survey of the Site, in conjunction with, or as instructed by, the Engineer's Representative, or of such parts of the Site as the Engineer's Representative may direct, to record the Site limits, dimensions, ground levels, obstructions and other features and to establish base lines and points for future setting out and to record the basis for re-measurement of excavation and earthwork, where applicable.

2 Setting out building works shall be performed using methods and measuring instruments described in BS 5606, Section 5 and within the permissible deviations described in Table 4 in relation to the instruments being used.
3 Setting out utility works shall be as shown on as the Drawings or the typical approved setting out cross sections by P.W.A. as instructed on Site. Stake-out shall be revised if, in the opinion of the Engineer's Representative, modification of line or grade is advisable.

4 Setting Out: Details of methods and equipment to be used in setting out the Works shall be submitted to the Engineer's Representative.

5 Setting Out: The Contractor shall inform the Engineer's Representative when setting out is complete and before commencing construction and shall provide instruments and assistance for checking the setting out if required by the Engineer's Representative.

6 Record Drawings: The Contractor shall record details of all grid lines, existing ground levels, setting-out stations, bench marks and profiles on the site setting-out drawing, retain on the Site throughout the duration of the Contract and hand to the Engineer's Representative on completion.

7 All dimensions and levels both on the Drawings and the Site, shall be checked, particularly the correlation between components and the work in place. Materials and components shall not be ordered or work carried out until any discrepancies have been resolved with the Engineer.

8 Tolerances: Works shall be constructed to achieve levels of accuracy within the permissible deviations of BS 5606, Tables 2 and 3, unless specified otherwise.

9 Appearance and Fit: The Works shall be constructed to higher levels of accuracy than those specified where necessary to achieve a satisfactory appearance and to ensure that materials, elements and components of the building fit together as designed. Wherever the accuracy, fit or appearance of the work is likely to be critical or difficult to achieve the Contractor shall obtain the Engineer's approval of proposals or of the partially finished work as early as possible.

10 Non-Compliance: Work which fails to meet the specified levels of accuracy must not be rectified without approval. Submit proposals for such rectification or removal and replacement and meet all costs arising, including effects on other work.

1.1.31 Defective Work

1 Suitability of previous work and conditions: Before starting each new type or section of work the Contractor shall ensure that:

2 Previous related work is appropriately complete and is to a suitable standard and in a suitable condition to receive the new work.

3 All necessary preparatory work has been carried out including provision for services, damp proofing, priming and sealing Environmental conditions are suitable, particularly that the building is suitably weather tight when internal components, services and finishes are installed.

4 Defects in existing work: The Contractor shall report to the Engineer's Representative if any existing work is defective and obtain his instructions before proceeding with new work which may cover up the defective work or which may be adversely affected by the defective work.
5 Rectification of defective work: If any part of the work is known or is suspected to be not in accordance with the Contract, the Contractor shall submit proposals to the Engineer for opening up, inspecting, testing and rectification and shall carry out the Engineer's instructions in relation thereto, including, where so instructed, removal and reconstruction.

1.1.32 Concurrent Work

1 Other work, not forming part of the Contract, will be carried out by the Employer or other contractors or public bodies on or near to the site during the execution of the Works. Allow for the co-ordination of this work to enable the work to proceed without disruption to the completion of the Works.

1.1.33 Completion

1 Notice of Completion: The Contractor shall give the Engineer's Representative at least four weeks' notice of the anticipated date of substantial completion of the whole or any part of the Works.

2 Making Good Defects: The Contractor shall make arrangements with the Employer and give reasonable notice of the dates for access to the various parts of the Works for the purpose of making good defects and shall inform the Engineer's Representative of the dates when remedial works to the various parts of the Works are completed.

1.1.34 Guarantees

1 Where the contract documents require work to be guaranteed against failure for a specific period, especially to failures incurred on roofing and roof waterproofing systems whether caused by defective materials or workmanship shall be guaranteed unconditionally for 7 years by the sub-contractor and the Contractor. All such guarantees shall be specifically written and signed by the sub-contractor and the Contractor for the particular work to take effect from the date of completion of the Works.

2 The Guarantees shall undertake to rectify any faults occurring through defective materials or workmanship within the stipulated period and to pay all costs in this connection and any related costs occasioned through damage or disturbance of any kind caused by the failure. The format of the guarantee shall be to the Engineer's approval.

3 When a failure of work covered by a guarantee has been rectified, the guarantee shall be reinstated to operate for a period of time equal to that of the original guarantee to take effect from the date of the acceptance of the rectified work.

4 The rights conferred by any guarantee shall be in addition to all other rights of the Engineer under the Contract.

5 The Contractor shall ensure that he obtains, for the benefit of the Engineer, a 7-year guarantee in respect of the performance of the roof waterproofing.
SECTION 2

BUILDING DEMOLITION (IF APPLICABLE)
1. GENERAL

1.1.1 Scope

_Delete Part 6 and 28_

1.1.3 Definition

_Delete Item No. 5_

1.5 Use of Explosive

_Delete Clause 1.5 entirely (1.5.1 and 1.5.2)._
2. BUILDING DEMOLITION

2.1 General

*Delete Sub-Clause 2.1.2 References.*

2.2.2 Execution

*Delete Item NO. 4*
SECTION 5

CONCRETE
2. AGGREGATES

2.1.3 Source Approval

Modify the following in Table 2.1:

7. Sand equivalent shall be min 75% for fine aggregates.

10. Flakiness and elongation index shall be 25% max for coarse aggregate for use in structural concrete.

12. Acid soluble sulphate for fine aggregate shall be max of 0.3%.

2.4 FINE AGGREGATE FOR CONCRETE AND MORTAR

2. The gradation of fine aggregate shall also be in accordance with ASTM C33.
3. CEMENT

3.1.1 Scope

Add the following:

3. Type of cement used shall be:
   (a) Ordinary Portland cement to BS EN 197-1 for all structural elements above grade castings.
   (b) Sulphate resistant Portland cement to BS 4027 for all structural elements below grade castings.

3.2 SOURCE APPROVAL

Add the following:

6 Obtain type or class of cement from single source and same manufacturer's plant.

3.4 QUALITY AND TESTING

Add the following:

2 Minimum clinker content shall be 95%.

3 For massive concrete structures, the heat of Hydration when using cement that meets the specified requirements shall not exceed 265 Kj/Kg after 7 days when tested in accordance with ASTM C 186.
4. WATER

4.1.2 References

Add the following:


4.3 TESTING AND SAMPLING

Amend Table 4.2 as follows:

Table 4.2 Chemical Limitations for Mixing Water

<table>
<thead>
<tr>
<th>Max.</th>
<th>Concentration</th>
<th>Test Method</th>
<th>Maximum Limit, mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Chloride (as Cl)</td>
<td>ASTM D512 or BS 1377: Part 3</td>
<td>500</td>
</tr>
<tr>
<td>(b)</td>
<td>Sulphates (as S0₃)</td>
<td>ASTM D516 or BS 1377: Part 3</td>
<td>1000</td>
</tr>
<tr>
<td>(c)</td>
<td>Alkali carbonates and bicarbonates</td>
<td>BS 2690 : Part 109</td>
<td>500</td>
</tr>
<tr>
<td>(d)</td>
<td>Total dissolved ions, including a, b and c above</td>
<td>BS 1377 : Part 3</td>
<td>2000</td>
</tr>
<tr>
<td>(e)</td>
<td>pH</td>
<td>BS 2690 : Part 5</td>
<td>7.0 - 9.0</td>
</tr>
</tbody>
</table>
5. ADMIXTURES

5.3.2 Pulverised Fuel Ash

*Replace item 5 by the following:*

5  Fly ash content shall not exceed 35% for Type F of the cementitious weight.

5.3.3 Silica Fume

*Replace item 1 by the following:*

1  Densified silica fume shall not exceed 10% by total weight of cementitious material and shall not be lower than 5% when used in the concrete mix.

*Add the following:*

6  Third generation admixture, Polycarboxylate Ether (PCE) shall be used if silica fume is added to the concrete mix or if self-compacting concrete is required.
6. PROPERTY REQUIREMENTS

6.1.3 Definitions

Amend the following:

6 Least dimension exceeds 1.0 meters.

6.4 Grades of Concrete

Amend Table 6.4 as follows:

Table 6.4: Concrete mixtures grades requirements

<table>
<thead>
<tr>
<th>Concrete Grade</th>
<th>Minimum Cube Compressive strength @ 28 days (N/mm²)</th>
<th>Aggregate size (mm)</th>
<th>Minimum cement Content (Kg/m³)</th>
<th>Maximum water cement ratio W/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>B15</td>
<td>15</td>
<td>20</td>
<td>250</td>
<td>0.55</td>
</tr>
<tr>
<td>C30</td>
<td>30</td>
<td>20</td>
<td>300</td>
<td>0.58</td>
</tr>
<tr>
<td>C45</td>
<td>45</td>
<td>20</td>
<td>355</td>
<td>0.47</td>
</tr>
<tr>
<td>C50</td>
<td>50</td>
<td>20</td>
<td>370</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Add note

Micro silica, cementitious additives, fly ash, GGBS or any other equivalent cementitious additions shall be added to the concrete mix to meet the durability requirements specified under table 6.8.

6.6 Design of Concrete Mixes

Add the following:

8 Concrete Grade is the characteristic strength at 28 days, at which not more than 5% of the cubes can be expected to fail.

9 The concrete mix for substructure concrete elements shall be of the "Moderately High Level durability".
6.6.1 Concrete

*Modify the following*

3 Mass Concrete

(a) The internal differential temperature of concrete shall not exceed 20°C for gabbro aggregates and 25°C for limestone aggregates.
8. TRANSPORTATION AND PLACING OF CONCRETE

8.2.1 General

Amend items 1 and 2 to read as follows:

1. Transportation delivery and handling shall be in accordance with the requirements of BS 8500, BS EN 206-1, and ASTM C 94M.

2. Concrete shall be conveyed from the mixer to its place in the Works within maximum 60 minutes, as rapidly as possible, by methods which will prevent segregation or drying out and ensure that the concrete is of the required workability at the point and time of placing.

8.2.2 Pumped Concrete

Replace item 3 by the following:

3. During placing concrete the end of the supply line shall be kept immersed in the concrete to assist compaction. Where immersion is not possible, the hose shall be kept as close as possible to the surface of the concrete, not higher than 1.5 meter in any case.
10. CURING

10.1.3 Submittals

_Add the following new item:_

2 The Contractor shall submit to the Engineer for approval the proposed method of curing thick concrete members, including method of controlling internal differential thermal strains by preventing the concrete from experiencing excessive temperature differential between the internal concrete and the surfaces.

10.2.1 General

_Add the following to item no. 2:_

2 Special care should be given for curing concrete members of a concrete mix containing fly ash, silica flume or any other pozzolans.
11. REINFORCEMENT

11.1.2 References

Add the following:

ASTM A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
BS 8666, Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete.
ASTM A 496 or BS 4483, Steel fabric for the reinforcement of concrete.
BS 5135, Specification for the process of arc welding of carbon and carbon manganese steels.
ASTM A 185, for welded steel wire fabric.
BS 8110, Structural use of concrete.
ISO 9000, Quality management and quality assurance standards.

11.2.1 Reinforcing Bars

Replace item no. 1 with the following:

1 Reinforcement shall be from one source approved by the Engineer. All main steel reinforcement bars shall comply with the requirements of QS ISO 6935, ASTM A 615M or BS 4449 with minimum yield strength of 500 MPa and maximum carbon content of 0.3%.

11.3.1 Sampling

Delete item no. 6.

11.5.3 Mechanical Splices

Add the following:

3 Minimum yield stress when tested shall exceed 135% of the specified yield stress of the deformed bars.
4 Adjustable wrenches that indicate sufficient tightness of the connection shall be used.

<table>
<thead>
<tr>
<th>Torque Table</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rebar</strong></td>
</tr>
<tr>
<td><strong>Torque +20%</strong></td>
</tr>
<tr>
<td><strong>Torque -20%</strong></td>
</tr>
</tbody>
</table>
11.6 PROTECTIVE COATINGS TO REINFORCEMENT

*Delete this clause (11.6) and all sub-clauses entirely.*
13. INSPECTION AND TESTING OF HARDENED CONCRETE

13.5.1 General

*Add the following:*

6 Testing of concrete surfaces hardness shall only be performed if instructed by the Engineer and shall not be used to evaluate concrete strength. It shall be used to evaluate surface hardness only.
14. PROTECTIVE TREATMENTS FOR CONCRETE

14.3 WATERPROOF MEMBRANE

14.3.1 General

*Delete item no. 2*

14.3.2 Materials

*Replace item no. 1 with the following:*

1. The material shall be flexible sheet compounded from PVC resin, plasticizers, stabilizers, fillers, and pigments and reinforced with nonwoven fiberglass.

*Add new item no. 4,5 as follows:*

4. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

5. Protection Mat:
   
   (a) Woven or nonwoven Geotextile water permeable and resistant to UV degradation, type and weight as recommended by manufacturer for application.
   
   (b) Cement Screed: Thickness As indicated on drawing.

14.3.3 Waterproof Membrane

*Replace table no. 14.1 with the following table:*

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Testing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness (mm)</td>
<td>min. 1.5 mm</td>
<td>EN 1849</td>
</tr>
<tr>
<td>Specific weight (kg/m²)</td>
<td>1.95 + 2%</td>
<td>EN 1849</td>
</tr>
<tr>
<td>Tensile strength (N/mm²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal direction</td>
<td>&gt; 11</td>
<td>ASTM D 638 M</td>
</tr>
<tr>
<td>Transverse direction</td>
<td>&gt; 11</td>
<td></td>
</tr>
<tr>
<td>Elongation to break (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal direction</td>
<td>&gt; 300 %</td>
<td>ASTM D 638 M</td>
</tr>
<tr>
<td>Transverse direction</td>
<td>&gt; 300 %</td>
<td></td>
</tr>
<tr>
<td>Puncture Resistance (mm)</td>
<td>&gt; 600</td>
<td>EN 16726</td>
</tr>
<tr>
<td>Hydrostatic pressure resistance (6 hours at 0.5 MPa)</td>
<td>Waterproof</td>
<td>EN 12310</td>
</tr>
</tbody>
</table>
### Item Value Testing Method

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Testing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root resistance</td>
<td>No penetration</td>
<td>DIN 4062</td>
</tr>
<tr>
<td>Tear Resistance (N)</td>
<td>≥ 102</td>
<td>ASTM D 1004</td>
</tr>
<tr>
<td>Resistance to Static Load</td>
<td>≥ 1700 N</td>
<td>EN 12730</td>
</tr>
</tbody>
</table>

### 14.3.4 Application

**Add the following new items:**

5. Install compartmented, loosely laid sheets over entire area to receive waterproofing according to manufacturer's written instructions.

6. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.

7. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fish mouths and blisters. Patch with sheet waterproofing extending beyond repaired areas in all directions.

8. Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions; surface preparation; membrane application, flashings, protection, and drainage components; and to furnish daily reports to Engineer.

9. Flood test each area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

10. Engage an independent testing agency to observe flood testing and examine terminations for evidence of leaks during flood testing.

11. Do not permit foot or vehicular traffic on unprotected membrane.

12. Protect waterproofing from damage and wear during remainder of construction period.

13. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
Add the following new Paragraphs

14.7  COLD APPLIED BITUMINOUS COATING

14.7.1  General

1 This Subpart covers the use of cold Applied Bituminous Coating for underground concrete foundations and sump pits as design drawings.

14.7.2  Materials

1 Bitumen emulsion-base, fibre reinforced, low viscosity, water borne, asbestos-free, dries to form flexible membrane. Comply with BS 3416, Type 1 or ASTM D449, Type 1.

14.7.3  Surface Preparation

1 Clean substrate of projections and substances detrimental to work; comply with recommendations of prime materials manufacturer.

2 Mask off adjoining surfaces not receiving waterproofing to prevent spillage or overspray affecting other construction.

3 Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

4 Remove fins, ridges, and other projections and fill honeycomb, aggregate pockets, and other voids.

14.7.4  Application

1 Apply waterproofing according to manufacturer's written instructions.

2 Start installing waterproofing in presence of manufacturer's technical representative.

3 Apply primer over prepared substrate.

4 Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

5 Install protection course with butted joints over nominally cured membrane before starting subsequent construction operations.

14.7.5  Warranty

1 Manufacturer's form, without monetary limitation, in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period of ten (10) years from date of substantial completion.
Add the following new clauses:

14.8 MODIFIED CEMENT WATERPROOFING

14.8.1 General

1 This Subpart covers the use of modified cement waterproofing for internal faces of underground concrete tanks and swimming pools.

14.8.2 Materials

1 Modified cement waterproofing: Cementitious, ready-mixed, efflorescence-free, surface waterproofing that requires only the addition of water; resistant to water and moisture but vapour permeable for all applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); with properties meeting or exceeding the following:

   (a) Permeability: at 9 m head when tested according to CE CRD-C 48.
   (b) Compressive Strength: 30 MPa at 28 days when tested according to ASTM C 109.
   (c) Flexural Strength: 7.0 MPa at 28 days when tested according to ASTM C 348.
   (d) Bonds strength: 2.0 MPa at 14 days when tested according to ASTM C 321.
   (e) Colour: As selected by Engineer from manufacturer's full range of standard colours.

2 Patching Mortar: Cementitious waterproofing and repair mortar for filling and patching tie holes, honeycombs, reveals, and other imperfections; with properties meeting or exceeding the following criteria:

   (a) Compressive Strength: 50 MPa at 28 days when tested according to ASTM C 109 M.
   (b) Flexural Strength: 5 MPa at 28 days when tested according to ASTM C 348.
   (c) Shrinkage: Minus 0.093 percent at 28 days and plus 0.073 percent at 90 days when tested according to ASTM C 596.

14.8.3 Surface Preparation

1 Comply with waterproofing manufacturer's written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to concrete or masonry surfaces.
14.8.4 Application
1. Comply with waterproofing manufacturer’s written instructions, unless more stringent requirements are indicated.
2. Dampen surface with water and maintain damp condition until applying waterproofing.
3. Number of Coats: As recommended by manufacture, but not less than 2, with maximum application thickness of 1.5 mm per coat for total thickness of 3 mm.
4. Apply first bond coat as a slurry with brush or stiff broom, and subsequent coats with brush, spray, or trowel to specified surface finish.
5. Dampen surface between coats.

14.8.5 Protection
1. Protect applied, modified cement waterproofing from rapid drying, severe weather exposure, and water accumulation. Maintain completed Work in moist condition for not less than seven days by covering with impervious sheeting or by other curing procedures recommended in writing by waterproofing manufacturer.

14.8.6 Warranty
1. Manufacturer’s form, without monetary limitation, in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period of ten (10) years from date of substantial completion.

14.9 GLASS FIBER-REINFORCED POLYESTER-GRP LINING

14.9.1 General
1. Summary
   (a) Cast-in-place reinforced concrete Domestic Tanks.
2. Reference Standards
   (a) The work of Glass fiber-Reinforced Polyester-GRP lining shall be performed in strict accordance with latest edition, the Specifications of the American Society for Testing and Materials (ASTM) as referenced throughout this section or other approved standards.
American Society for Testing and Materials

ASTM No.

D2196 STANDARD TEST METHODS FOR RHEOLOGICAL PROPERTIES OF NON-NEWTONIAN MATERIALS BY ROTATIONAL (BROOKFIELD TYPE) VISCOMETER

D2583 STANDARD TEST METHOD FOR INDENTATION HARDNESS OF RIGID PLASTICS BY MEANS OF A BARCOL IMPRESSOR

D3278 STANDARD TEST METHODS FOR FLASH POINT OF LIQUIDS BY SMALL SCALE CLOSED-CUP APPARATUS

D 4258 Practice for Surface Cleaning Concrete for Coating

D 4259 Practice for Abrading Concrete

(b) In the event of conflict between the various codes and standards the most stringent conditions shall apply.

3 Submittals

(a) Submit the following in accordance with Conditions of the Contract:

(i) Product Data: For each type of Materials specified provide technical data and tested physical and performance properties and include manufacturer’s printed instructions for evaluating, preparing and treating the substrate.

(ii) Samples: For each type of lining material required, provide a GRP lining to deck to demonstrate surface preparation, texture and workmanship on a 300 x 300 mm tile or hardboard.

(iii) Shop Drawings: Showing location and extent of GRP lining, including details of substrate joints and cracks, sheet flashing, penetration, inside and outside corners, and other termination conditions.

4 Quality Assurance

(a) Manufacturer Qualifications: Employ materials produced by an experienced manufacturer who has produced GRP lining similar in materials to that indicated for project and that has resulted in construction with a record of successful in-service performance.

(b) Single Source Responsibility: Obtain GRP lining materials from a single manufacturer experienced in manufacturing GRP lining.

(c) Mock-ups: Apply GRP lining to 10.0 m² to demonstrate surface preparation, cracks and joint treatments, corner treatments, thickness, texture and execution quality.

5 Project Conditions

(a) Substrate: Proceed with GRP lining work only after substrate construction and penetrating work have been completed.
Do not apply GRP lining to a damp or wet substrate.

6 Delivery, Storage and Handling

(a) Materials shall be delivered to Site in the manufacturer's original containers with tightly closed labeled packages.

(b) Labels shall indicate:
   (i) Manufacturer's name or trademark
   (ii) Dates of manufacture and expiry
   (iii) Ingredients
   (iv) Method of application and mixing with other components

(c) Store materials in their original undamaged containers in clean, dry, weatherproofed locations complying with manufacturer's recommendations. Materials that cannot be applied within its stated shelf life shall be rejected and removed from Site.

(d) Protect stored materials from direct sunlight.

(e) Handle materials carefully during delivery or transit. Do not cut or break original packages.

7 Special Warranty

(a) The Contractor agrees to repair or replace GRP lining that does not meet requirements or does not remain watertight within a period of 5 years after date of Substantial Completion.

14.9.2 Products

1 Provide GRP lining materials that prevent the passage of water under conditions of service and application required as demonstrated by GRP lining manufacturer based on testing and field experience.

2 The following materials shall be approved and shall be used as per the Finishing schedule:

   (a) Polyester Resin.
   (b) Gelcoat.
   (c) Glass fibre mat- E Glass strand mat.

3 Isophthalic Polyester Resin

   (a) Provide medium reactive isophthalic polyester resin with generally good mechanical properties, impact strength in particular.

   (b) Provide isophthalic polyester resin thixotropic, accelerated and has a viscosity that ensures thorough glass fiber impregnation. Built-in accelerator system gives relatively long gel time, rapid curing combined
with relatively low exothermic temperature and short demoulding time.

(c) It shall be extra stabilized for prolonged shelf life at elevated temperature and geltime adjusted for comfortable process time even at higher ambient temperature.

(d) The polyester resin is specially designed to resist water, oil, and less aggressive chemicals and suitable for production of tanks.

(e) PHYSICAL DATA IN LIQUID STATE AT 23°C:

<table>
<thead>
<tr>
<th>Properties</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity - Brookfield LVF 2/12rpm</td>
<td>1300 – 1500</td>
<td>mPa’s (cP)</td>
</tr>
<tr>
<td>Viscosity - Cone &amp; Plate</td>
<td>280 – 330</td>
<td>mPa’s (cP)</td>
</tr>
<tr>
<td>Density</td>
<td>1.10 ± 0.03</td>
<td>g/cm³</td>
</tr>
<tr>
<td>Acid number (max.)</td>
<td>15</td>
<td>Mg KOH/g</td>
</tr>
<tr>
<td>Styrene content</td>
<td>44 ± 2</td>
<td>% weight</td>
</tr>
<tr>
<td>Storage stability from date of manufacture</td>
<td>6</td>
<td>°C / °F</td>
</tr>
</tbody>
</table>

(f) MECHANICAL/PHYSICAL DATA IN CURED STATE:

<table>
<thead>
<tr>
<th>Properties</th>
<th>Pure resin</th>
<th>Reinforced</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass content</td>
<td>-</td>
<td>33</td>
<td>% weight</td>
</tr>
<tr>
<td>Density</td>
<td>1.20</td>
<td>1.46</td>
<td>g/cm³</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>72</td>
<td>125</td>
<td>MPa</td>
</tr>
<tr>
<td>Tensile modulus</td>
<td>3650</td>
<td>7300</td>
<td>MPa</td>
</tr>
<tr>
<td>Tensile elongation</td>
<td>4.0</td>
<td>2.5</td>
<td>%</td>
</tr>
<tr>
<td>Flexural strength</td>
<td>140</td>
<td>190</td>
<td>MPa</td>
</tr>
<tr>
<td>Flexural modulus</td>
<td>3300</td>
<td>7200</td>
<td>MPa</td>
</tr>
<tr>
<td>Impact strength, P 4 J</td>
<td>12</td>
<td>75</td>
<td>mJ/mm²</td>
</tr>
<tr>
<td>Volume shrinkage</td>
<td>7</td>
<td>-</td>
<td>%</td>
</tr>
<tr>
<td>Heat distortion temp.</td>
<td>86</td>
<td>-</td>
<td>°C</td>
</tr>
<tr>
<td>Hardness Barcol</td>
<td>40</td>
<td>45</td>
<td>934-1</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>0.17</td>
<td>-</td>
<td>%</td>
</tr>
<tr>
<td>Water Absorption - After 24 hours</td>
<td>0.90</td>
<td>-</td>
<td>%</td>
</tr>
<tr>
<td>Water Absorption - After 28 days</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 E-Glass Chopped Strand Mat

(a) E-Glass CSM shall be chopped strand mat for hand lay-up contact molding with excellent performance.
(i) Good wet-out properties
(ii) Multi-resin-compatible
(iii) Good tensile strength with flexibility
(iv) Highly soluble resin binder
(v) Excellent fiber distribution
(vi) Uniform weight
(vii) Excellent translucency

(b) Technical data:
(i) Area Weight 450±10% G/m²
(ii) Binder Content 3.7±0.8 %
(iii) Water Content <0.2 %
(iv) Tensile Strength 70 MD N/150 mm
(v) Tensile Strength 70 CD N/150 mm
(vi) Width 1000 mm
(vii) Permeation Rate <50 s
(viii) Color White, slightly yellow

5 gelcoat

(a) shall be a gelcoat based on iso-modified polyester resin.
(b) shall be meet the most stringent requirements for working properties and is formulated to give glassfibre-reinforced polyester resin products good weather and water resistant surface protection.
(i) Recommended film thickness: 0.55-0.85 mm (wet film)

(c) PHYSICAL DATA IN LIQUID STATE AT 23°C:

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit / mPa·s(cP)</th>
<th>Spray</th>
<th>Hand quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity - Brookfield RVF sp.4/4 rpm</td>
<td></td>
<td>9000-15000</td>
<td>14000-20000</td>
</tr>
<tr>
<td>Viscosity - Cone &amp; Plate mPa·s(cP)</td>
<td></td>
<td>220-300</td>
<td>750-900</td>
</tr>
<tr>
<td>Density g/cm³</td>
<td></td>
<td>1.1-1.3</td>
<td>1.1-1.3</td>
</tr>
</tbody>
</table>

(d) MECHANICAL/PHYSICAL DATA FOR THE GELCOAT’S BASE POLYESTER RESIN IN CURED STATE

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength</td>
<td>MPa</td>
<td>min. 60</td>
</tr>
<tr>
<td>Tensile modulus</td>
<td>MPa</td>
<td>min. 3500</td>
</tr>
<tr>
<td>Tensile elongation</td>
<td>%</td>
<td>min. 2.5</td>
</tr>
<tr>
<td>Heat distortion temp.</td>
<td>°C</td>
<td>min. 80</td>
</tr>
<tr>
<td>Hardness Barcol</td>
<td>-</td>
<td>min. 40</td>
</tr>
<tr>
<td>Water absorption</td>
<td>mg/testpiece</td>
<td>max. 80</td>
</tr>
</tbody>
</table>
14.9.3 Execution

1 Preparation of Substrate

(a) Clean substrate of projections and substances detrimental to work; comply with recommendations of prime materials manufacturer.

(b) Verify that substrate is visibly dry; and free of moisture.

(c) Fill voids, seal joints and cracks exceeding 1.6 mm wide and apply bond breakers (if any) as recommended by materials manufacturer, with particular attention to construction joints.

(d) All vertical surfaces shall be firm, hard, smooth and dry and shall be thoroughly chipped, wire brushed and washed with clean water to present a new fresh and clean surface to which material shall bond.

(e) Provide sealant cants and a preparatory membrane around penetrations and at inside corners of slab-to-wall, butt joints.

(f) Prime Coat of polyester resin as recommended by manufacturer.

(g) Install sheet flashing and bond to slab and wall substrates where required.

2 Protection of Other Work

(a) Close off drains and other deck penetrations. Do not allow liquid compounds to enter and clog drains and conduits. Prevent spillage and migration onto other surfaces of work, by masking or otherwise protecting adjoining work.

3 Application

(a) Proceed with installation only after the minimum recommended concrete curing period.

(b) Comply with manufacturer's recommendations, except where more stringent requirements are indicated or specified and where project conditions require extra precautions or provisions to ensure satisfactory performance of work.

(c) A prime coat of polyester resin is applied to cover all pores and undulations to form a good binder using a roller. Care is taken to obtain an even surface.

(d) Place one layer of E Glass CSM (Chopped Strand Matt) 450gms/ m2 density.

(e) Apply one coat of polyester resin on fibre mat and roll properly of expel all entrapped air.

(f) Repeat item 4.2 and 4.3 until 3 layers of E Glass CSM is placed in position.

(g) Number of layers is determined by manufacture but not less than 3 layers.

(h) Roll out and consolidate, so that all entrapped air goes out and that no air
pockets or bubbles occur. It is then allowed to dry for 24 hours prior to application of final coat.

(i) A final coat (white gel coat) with rate of 600 gms/m2.

(i) As indicated, and whether or not shown on Drawings, apply GRP lining to all interior surfaces of underground tanks.

(j) GRP lining on Interior Surfaces: Shall be applied all around concrete and wall tank elements.

(k) Prepare vertical and horizontal surfaces at terminations and penetrations through GRP lining and at expansion joints, sleeves and drains.

(m) Apply waterproofing to vertical surfaces to height indicated. Obtain a seamless membrane free of entrapped gases.

(n) Install sheet flashing if indicated and bond to substrates according to manufacturers.

4 Protection Course and Field Test

(a) Protect GRP lining materials after acceptance by Engineer.

(b) Care should be taken to avoid any bodily contact.

(c) All work during & after execution will be well protected against weather, direct sunlight and physical abuse.

(d) Engage a testing agency to perform field inspections, test materials being used, observe flood test and report whether tested work conforms to or deviates from requirements.

(e) Testing agency shall verify thickness of GRP lining.

5 Protection and Clean-up

(a) Protection: Protect GRP lining after acceptance by the Engineer. Institute required procedures for protection of completed work during installation of subsequent work.

(b) Clean spillage and soiling from adjacent construction using cleaning agents.

(c) Cleaning: The Contractor shall remove all equipment, rubbish, debris and clean the Site to the satisfaction of the Engineer.
20 LIGHTWEIGHT INSULATING CONCRETE

Add the following Part

20.1 SUMMARY
1 This Section includes cast-in-place lightweight insulating concrete for roof

20.2 DEFINITIONS
1 Lightweight Insulating Concrete: Low-density concrete, with an oven-dry unit weight not exceeding 800 kg/cu. m, placed with or without embedded rigid insulation board.

20.3 SUBMITTALS
1 Product Data: For each type of product indicated. Include mixing and application instructions for each type of lightweight insulating concrete.
2 Shop Drawings: Include plans, sections, and details showing roof slopes, lightweight insulating concrete thicknesses, embedded insulation board, roof penetrations, roof perimeter terminations and curbs, control and expansion joints, and roof drains.
3 Design Mixtures: For each lightweight insulating concrete mix.
4 Material Test Reports: For lightweight aggregates, from a qualified testing agency, indicating compliance with requirements.
5 Material Certificates: For each of the following, signed by manufacturers:
   (a) Cementitious materials.
   (b) Foaming agents.
   (c) Admixtures.
   (d) Molded-polystyrene insulation board.
6 Field quality-control test reports.
7 Research/Evaluation Reports: For lightweight insulating concrete.

20.4 QUALITY ASSURANCE
1 Installer Qualifications: A firm that is approved by lightweight insulating concrete manufacturer.
2 Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
3 Fire-Test-Response Characteristics: Where lightweight insulating concrete is part of a fire-resistance-rated roof-deck assembly, provide lightweight insulating concrete identical to that used in assemblies tested for fire resistance per ASTM E 119 by a testing agency acceptable to authorities having jurisdiction.

20.5 DELIVERY, STORAGE, AND HANDLING

1 Deliver materials in manufacturer's original undamaged packages or acceptable bulk containers.

2 Store packaged materials to protect them from elements or physical damage.

3 Do not use cement that shows indications of moisture damage, caking, or other deterioration.

20.6 MATERIALS

1 Cementitious Material: Portland cement, ASTM C 150, Type II Supplement with fly ash, ASTM C 618, Class C or F.

2 Mineral Aggregate: ASTM C 332, Group I, perlite

3 Foaming Agent: ASTM C 869.

4 Water: Clean, potable.


6 Joint Filler: ASTM C 612, Class 2, glass-fiber type; compressing to one-half thickness under a load of 172 kPa.

7 Steel Wire Mesh: Cold-drawn steel wire, galvanized, 1.04-mm diameter, woven into 50-mm hexagonal mesh, and reinforced with a longitudinal 1.57-mm-diameter wire spaced 75 mm apart.

8 Available Product: Subject to compliance with requirements, a product that may be incorporated into the Work includes, but is not limited to, "Keydeck," Style No. 2160-2-1619, by Keystone Steel & Wire.

9 Product: Subject to compliance with requirements, provide "Keydeck," Style No. 2160-2-1619, by Keystone Steel & Wire.

10 Galvanized Plain-Steel Welded Wire Reinforcement: ASTM A 185, 50 by 50 mm, W0.5 by W0.5, fabricated from galvanized steel wire into flat sheets.

11 Molded-Polystyrene Insulation Board: ASTM C 578, Type I, 14.4-kg/cu. m minimum density.

12 Provide units with keying slots of approximately 3 percent of board's gross surface area.
20.7 DESIGN MIXTURES

1 Prepare design mixtures for each type and strength of lightweight insulating concrete by laboratory trial batch method or by field-test data method. For trial batch method, use a qualified independent testing agency for preparing and reporting proposed mixture designs.

2 Limit use of fly ash to not exceed 25 percent of portland cement by weight.

3 Limit water-soluble chloride ions to the maximum percentage by weight of cement or cementitious material permitted by ACI 301.

20.8 AGGREGATE LIGHTWEIGHT INSULATING CONCRETE

1 Produce lightweight insulating concrete using the minimum amount of water necessary to produce a workable mix.

2 Do not exceed maximum air content recommended by aggregate manufacturer.

3 Perlite Aggregate Mix: Lightweight insulating concrete produced from cementitious materials, water, air-entraining admixture, and perlite mineral aggregates with the following physical properties:

4 As-Cast Unit Weight: 610 to 705 kg/cu. m at point of placement, when tested according to ASTM C 138/C 138M.

5 Oven-Dry Unit Weight: 385 to 480 kg/cu. m, when tested according to ASTM C 495.

6 Compressive Strength: Minimum 860 kPa, when tested according to ASTM C 495.

7 Cement-to-Aggregate Ratio, by Volume: 1:6

20.9 PREPARATION

1 Control Joints: Install control joints at perimeter of roof deck and at junctures with vertical surfaces, including curbs, walls, and vents, for full depth of lightweight insulating concrete. Fill control joints with joint filler.

2 Provide 25-mm- wide control joints for roof dimensions up to 30 m in length; 38-mm- wide control joints for roof dimensions exceeding 30 m.

3 Wire Mesh: Place steel wire mesh with longest dimension perpendicular to steel deck ribs. Cut mesh to fit around roof openings and projections. Terminate mesh at control joints. Lap sides and ends of mesh at least 150 mm.

4 Welded Wire Reinforcement: Place steel welded wire reinforcement with longest dimension perpendicular to steel deck ribs. Cut reinforcement to fit around roof
openings and projections. Terminate reinforcement at control joints. Lap sides and ends of reinforcement at least 150 mm.

20.10 MIXING AND PLACING

1. Mix and place lightweight insulating concrete according to manufacturer’s written instructions, using equipment and procedures to avoid segregation of mixture and loss of air content.

2. Install insulation board according to lightweight insulating concrete manufacturer’s written instructions. Place insulation board in wet, lightweight insulating concrete slurry poured a minimum of 3 mm over the structural substrate. Ensure full contact of insulation board with slurry. Stagger joints and tightly butt insulation boards.

3. Install insulation board in a stair-step configuration with a maximum step-down of 25 mm.

4. Deposit and screed lightweight insulating concrete in a continuous operation until an entire panel or section of roof area is completed. Do not vibrate or work mix except for screeding or floating. Place to depths and slopes indicated.

5. Finish top surface smooth, free of ridges and depressions, and maintain surface in condition to receive subsequent roofing system.

6. Begin curing operations immediately after placement, and air cure for not less than three days according to manufacturer’s written instructions.

7. If ambient temperature falls below 0 deg C, protect lightweight insulating concrete from freezing and maintain temperature recommended by manufacturer for 72 hours after placement.

20.11 FIELD QUALITY CONTROL

1. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform field tests and inspections, and prepare test reports.

2. Testing of samples of lightweight insulating concrete obtained according to ASTM C 172, except as modified by ASTM C 495, shall be performed according to the following requirements:

3. Determine as-cast unit weight during each hour of placement, according to ASTM C 138/C 138M.

4. Determine oven-dry unit weight and compressive strength according to ASTM C 495. Make a set of at least 6 molds for each day’s placement, but not less than 1 set of molds for each [465 sq. m] <Insert measurement> of roof area.

5. Perform additional tests when test results indicate as-cast unit weight, oven-dry unit weight, compressive strength, or other requirements have not been met.
6 Retest cast-in-place lightweight insulating concrete according to ASTM C 513 for oven-dry unit weight and compressive strength.

20.12 DEFECTIVE WORK

1 Refinish, or remove and replace, lightweight insulating concrete if surfaces are excessively scaled or too rough to receive roofing according to roofing membrane manufacturer's written requirements.

2 Remove and replace lightweight insulating concrete that fails to comply with requirements.
SECTION 6

ROADWORKS
3. EARTHWORKS

3.5 EXCAVATION GENERAL

3.5.3 Rock Excavation

Items 1, 2, 10 & 11 refer to QCS 2014

*Delete items 3, 4, 5, 6, 7, 8 and 9 and replace with the below text:*

No Excavations using blasting is allowed.

3.8 FORMATION PREPARATION

3.8.2 Protection

Items 1, 2, 3 and 4 refer to QCS 2014

*Delete item 5 and replace it with the below text:*

The Contractor shall maintain the subgrade by spreading water and blading and rolling as frequently as may be necessary to preserve the subgrade in a completely satisfactory condition.
4. UNBOUND PAVEMENT MATERIALS

4.4. MIX DESIGN

Delete item 3
5. ASPHALT WORKS

Omit entire part
6. CONCRETE ROAD PAVEMENTS

Omit entire part
7. ASPHALT PLANTS

Omit entire part
8. RECYCLED AND STABILISED ROAD MATERIALS

Omit entire part
9. RECYCLED AGGREGATE FOR ROADWORKS

Omit entire part
10. VEHICLE CRASH BARRIERS

Omit entire part
11. KERBS, FOOTWAYS, AND PAVED AREAS

11.4. LAYING PRECAST CONCRETE PAVING BLOCKS

Refer to QCS 2014 except for:

Delete item 1 and replace it with the following item:

The paving blocks shall be laid generally in accordance with BS 7533-3 and completed in herringbone pattern (either 45 or 90 degree).
12. FENCING

Omit entire part
15. CAR WHEEL STOPPER

Scope

Pre-Cast Concrete Wheel Stop Minimum 30mpa concrete using off white cement.
Finish - Sand blasted

Dimension: As Indicated in Drawing

Color: As Approved By Engineer
16. TRAFFIC SIGNALS

Omit entire part
17. ROAD DRAINAGE

17.6. SOAKAWAYS

Omit this clause

17.9. TRENCH SOAKAWAYS

Omit this clause

17.10. GEOCELLULAR TANKS

Omit this clause
19. MISCELLANEOUS

Refer to QCS 2014 and add the following:

19.6. CAR WHEEL STOPPER

Scope

Pre-Cast Concrete wheel stop minimum 30mpa concrete using off white cement.
Finish - Sand blasted

Dimension: As Indicated in Drawings.

Color: As Approved By Engineer.
SECTION 7 – GREEN CONSTRUCTION
1. GSAS AND SUSTAINABILITY INTRODUCTION

1.1 GENERAL

1 The purpose of this section is to ensure that sustainability is incorporated in the project and is documented in compliance with the Global Sustainability Assessment System (GSAS).

2 The project in its current status is under pre-assessment stage and is targeted to achieve 3 stars certification level, hence all criteria Target scores indicated in this section are preliminary scores and are subject to GSAS final stage documentations and approved provisional certification level.

3 The contractor has to provide complete documentation including submittals, data sheets, calculations, drawings and reports o the engineer to the level of his satisfaction in accordance with the GSAS requirement demonstrating compliance with the GSAS and sustainability objectives

1.2 INTRODUCTION AND DEFINITIONS

1.2.1 GSAS:

1 GSAS, Global Sustainability Assessment System, the first of its kind performance-based sustainability rating scheme for the construction industry developed by GORD “Gulf Organization for Research and Development” in collaboration with TC Chan Center at the University of Pennsylvania, USA.

2 The primary objective of GSAS is to create a sustainable built environment that minimizes ecological impact while addressing the specific regional needs and environment of Qatar.

1.2.2 GSAS Overseeing Body:

1 GORD, Gulf Organization for Research & Development - is a fully governmental Organization located at the Qatar Science and Technology Park (QSTP); whose purpose is to promote healthy, energy & resource efficient, and environmentally responsible building practices in Qatar and the entire Gulf region

2 GORD is the Overseeing body responsible for registering the projects and issuing the certification and approvals and reviewing the submitted documents in all the stages of the projects from the design, construction up to the operation of the projects.

1.2.3 GSAS Elements:

1 GSAS is divided into eight categories, each with a direct impact on environmental stress mitigation. Each category measures a different aspect of the project’s environmental impact.
2 These categories are then broken down into specific criteria that measure and define these individual issues. These issues range from a thorough review of water consumption to an assessment of light quality.

3 Each criterion specifies a process for measuring individual aspects of the criterion's environmental impact and supporting it with the required documentation. A score is then awarded to each criterion based on the level of compliance.

1.2.4 GSAS Categories:

1 GSAS are divided into eight categories.

   (a) Urban Connectivity [UC]

   (i) The Urban Connectivity category consists of factors associated with the urban environment such as Zoning, transportation networks and loadings.

   (b) Site [S]

   (i) The Site category consists of factors associated with land use.

   (c) Energy [E]

   (i) The Energy category consists of factors associated with energy demand of buildings, the efficiency of energy delivery, and the use of fossil energy sources that result in harmful emissions.

   (d) Water [W]

   (i) The Water category consists of factors associated with water consumption and its associated burden on municipal supply and treatment systems.
(e) Materials [M]
   (i) The Materials category consists of factors associated with material processing, manufacturing, distribution, use/reuse, and disposal.

(f) Indoor Environment [IE]
   (i) The Indoor Environment category consists of factors associated with indoor environment quality such as thermal comfort, air quality, acoustic quality, and light quality.

(g) Cultural & Economic Value [CE]
   (i) The Cultural & Economic Value category consists of factors associated with cultural conservation and support of the national economy.

(h) Management & Operations [MO]
   (i) The Management & Operations category consists of factors associated with building design management and operation.

1.2.5 GSAS Criteria:

1. The following Chart summarizes the GSAS Criteria applicable to each typology:
# Health Care Assessment Scheme v2.0-2013 - Part I

<table>
<thead>
<tr>
<th>No</th>
<th>Category / Criteria</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC</td>
<td>Urban Connectivity</td>
<td>8.00%</td>
</tr>
<tr>
<td></td>
<td>UC.1 Proximity to Infrastructure</td>
<td>1.42%</td>
</tr>
<tr>
<td></td>
<td>UC.2 Load on Local Traffic Conditions</td>
<td>1.78%</td>
</tr>
<tr>
<td></td>
<td>UC.3 Public Transportation</td>
<td>1.28%</td>
</tr>
<tr>
<td></td>
<td>UC.4 Private Transportation</td>
<td>0.38%</td>
</tr>
<tr>
<td></td>
<td>UC.5 Sewer &amp; Waterway Contamination</td>
<td>1.06%</td>
</tr>
<tr>
<td></td>
<td>UC.6 Acoustic Conditions</td>
<td>0.26%</td>
</tr>
<tr>
<td></td>
<td>UC.7 Proximity to Amenities</td>
<td>0.68%</td>
</tr>
<tr>
<td></td>
<td>UC.8 Accessibility</td>
<td>1.14%</td>
</tr>
<tr>
<td>S</td>
<td>Site</td>
<td>9.00%</td>
</tr>
<tr>
<td></td>
<td>S.1 Land Preservation</td>
<td>2.85%</td>
</tr>
<tr>
<td></td>
<td>S.2 Water Body Preservation</td>
<td>3.79%</td>
</tr>
<tr>
<td></td>
<td>S.3 Habitat Preservation</td>
<td>2.85%</td>
</tr>
<tr>
<td></td>
<td>S.4 Vegetation</td>
<td>2.28%</td>
</tr>
<tr>
<td></td>
<td>S.5 Desertification</td>
<td>2.28%</td>
</tr>
<tr>
<td></td>
<td>S.6 Rainwater Runoff</td>
<td>1.90%</td>
</tr>
<tr>
<td></td>
<td>S.7 Heat Island Effect</td>
<td>0.95%</td>
</tr>
<tr>
<td></td>
<td>S.8 Adverse Wind Conditions</td>
<td>0.95%</td>
</tr>
<tr>
<td></td>
<td>S.9 Noise Pollution</td>
<td>0.95%</td>
</tr>
<tr>
<td></td>
<td>S.10 Light Pollution</td>
<td>1.27%</td>
</tr>
<tr>
<td></td>
<td>S.11 Shading of Adjacent Properties</td>
<td>1.27%</td>
</tr>
<tr>
<td></td>
<td>S.12 Parking Footprint</td>
<td>1.90%</td>
</tr>
<tr>
<td></td>
<td>S.13 Shading</td>
<td>0.85%</td>
</tr>
<tr>
<td></td>
<td>S.14 Illumination</td>
<td>1.14%</td>
</tr>
<tr>
<td></td>
<td>S.15 Pathways</td>
<td>1.14%</td>
</tr>
<tr>
<td>E</td>
<td>Energy</td>
<td>25.00%</td>
</tr>
<tr>
<td></td>
<td>E.1 Energy Demand Performance</td>
<td>5.20%</td>
</tr>
<tr>
<td></td>
<td>E.2 Energy Delivery Performance</td>
<td>5.20%</td>
</tr>
<tr>
<td></td>
<td>E.3 Fossil Fuel Conservation</td>
<td>3.64%</td>
</tr>
<tr>
<td></td>
<td>E.4 CO2 Emissions</td>
<td>4.54%</td>
</tr>
<tr>
<td></td>
<td>E.5 NOx, SOx, &amp; Particulate Matter</td>
<td>5.42%</td>
</tr>
<tr>
<td></td>
<td>E.6 Vertical Transportation</td>
<td>1.00%</td>
</tr>
</tbody>
</table>
### Health Care Assessment Scheme v2.0-2013 - Part II

<table>
<thead>
<tr>
<th>No</th>
<th>Category / Criteria</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>Water</td>
<td>15.00%</td>
</tr>
<tr>
<td>W.1</td>
<td>Water Consumption</td>
<td>13.50%</td>
</tr>
<tr>
<td>W.2</td>
<td>Prevention against Legionella</td>
<td>1.50%</td>
</tr>
<tr>
<td>M</td>
<td>Materials</td>
<td>8.00%</td>
</tr>
<tr>
<td>M.1</td>
<td>Regional Materials</td>
<td>1.45%</td>
</tr>
<tr>
<td>M.2</td>
<td>Responsible Sourcing of Materials</td>
<td>1.70%</td>
</tr>
<tr>
<td>M.3</td>
<td>Structure Reuse: Off Site</td>
<td>0.73%</td>
</tr>
<tr>
<td>M.4</td>
<td>Materials Reuse: Off Site</td>
<td>1.22%</td>
</tr>
<tr>
<td>M.5</td>
<td>Recycled Materials</td>
<td>1.45%</td>
</tr>
<tr>
<td>M.6</td>
<td>Design for Disassembly</td>
<td>1.45%</td>
</tr>
<tr>
<td>IE</td>
<td>Indoor Environment</td>
<td>16.00%</td>
</tr>
<tr>
<td>IE.1</td>
<td>Thermal Comfort</td>
<td>1.37%</td>
</tr>
<tr>
<td>IE.2</td>
<td>Natural Ventilation</td>
<td>1.83%</td>
</tr>
<tr>
<td>IE.3</td>
<td>Mechanical Ventilation</td>
<td>1.83%</td>
</tr>
<tr>
<td>IE.4</td>
<td>Illumination Levels</td>
<td>1.37%</td>
</tr>
<tr>
<td>IE.5</td>
<td>Daylight</td>
<td>1.83%</td>
</tr>
<tr>
<td>IE.6</td>
<td>Glare Control</td>
<td>1.37%</td>
</tr>
<tr>
<td>IE.7</td>
<td>Views</td>
<td>1.37%</td>
</tr>
<tr>
<td>IE.8</td>
<td>Acoustic Quality</td>
<td>1.37%</td>
</tr>
<tr>
<td>IE.9</td>
<td>Low-Emitting Materials</td>
<td>1.83%</td>
</tr>
<tr>
<td>IE.10</td>
<td>Indoor Chemical &amp; Pollutant Source Control</td>
<td>1.83%</td>
</tr>
<tr>
<td>CE</td>
<td>Cultural &amp; Economic Value</td>
<td>13.00%</td>
</tr>
<tr>
<td>CE.1</td>
<td>Heritage &amp; Cultural Identity</td>
<td>8.13%</td>
</tr>
<tr>
<td>CE.2</td>
<td>Support of National Economy</td>
<td>4.88%</td>
</tr>
<tr>
<td>MO</td>
<td>Management &amp; Operations</td>
<td>6.00%</td>
</tr>
<tr>
<td>MO.1</td>
<td>Commissioning Plan</td>
<td>0.45%</td>
</tr>
<tr>
<td>MO.2</td>
<td>Organic Waste Management</td>
<td>1.22%</td>
</tr>
<tr>
<td>MO.3</td>
<td>Recycling Management</td>
<td>1.60%</td>
</tr>
<tr>
<td>MO.4</td>
<td>Leak Detection</td>
<td>0.30%</td>
</tr>
<tr>
<td>MO.5</td>
<td>Energy &amp; Water Use Sub-metering</td>
<td>0.30%</td>
</tr>
<tr>
<td>MO.6</td>
<td>Automated Control System</td>
<td>0.45%</td>
</tr>
<tr>
<td>MO.7</td>
<td>Hospitality Management Plan</td>
<td>1.13%</td>
</tr>
<tr>
<td>MO.8</td>
<td>Sustainability Education &amp; Awareness Plan</td>
<td>0.55%</td>
</tr>
</tbody>
</table>

#### 1.2.6 GSAS Schemes and Typologies:

1. Listed below are the schemes and Typologies that are applicable for the project:
(a) Health Care:
  (i) Intended for rating the ecological impacts of new healthcare buildings, including specialist hospitals, general hospitals, out-patient hospitals, and primary care health centers.

1.2.7 GSAS Buildings Stars Levels:

1 Each criterion and category has an associated weight based on its relative environmental impact. Once a score is assigned to each criterion (Criterion score) in the assessment system, the final score is determined.

2 GSAS consists of six Stars Levels to define the degree of compliance as 1, 2,3,4,5, or 6 Stars Level; the following table summarizes the Stars Levels.

<table>
<thead>
<tr>
<th>Final Score (X)</th>
<th>Stars Level</th>
<th>GSAS Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>X &lt; 0</td>
<td>--</td>
<td>Certification denied</td>
</tr>
<tr>
<td>0.0 ≤ X ≤ 0.5</td>
<td>★</td>
<td>Certification achieved</td>
</tr>
<tr>
<td>0.5 ≤ X ≤ 1.0</td>
<td>★★</td>
<td></td>
</tr>
<tr>
<td>1.0 ≤ X ≤ 1.5</td>
<td>★★★</td>
<td></td>
</tr>
<tr>
<td>1.5 ≤ X ≤ 2.0</td>
<td>★★★★</td>
<td></td>
</tr>
<tr>
<td>2.0 ≤ X ≤ 2.5</td>
<td>★★★★★</td>
<td></td>
</tr>
<tr>
<td>2.5 ≤ X ≤ 3.0</td>
<td>★★★★★★</td>
<td></td>
</tr>
</tbody>
</table>

1.2.8 GSAS Design Verification

1 The goal of GSAS Design verification is to ensure that initial criteria submittals are consistent with the built environment after the construction process is complete. Thus, verification will take place in two phases—Initial Review and Final Review.

2 During Initial Review, projects assessed under GSAS Design that achieves at least a 1 Star rating will be issued a provisional certificate. The provisional certificate enables the project to apply for a permit to begin the construction process. The provisional certificate does not designate the project as a GSAS certified building.

3 After construction is complete, projects must resubmit certain requirements for Final Review. Re-submittal requirements are the following:

(a) All criteria within the Materials category
(b) [S.1] Land Preservation
(c) [S.2] Water Body Preservation
(d) [S.3] Habitat Preservation
(e) [S.7] Heat Island Effect
(f) [IE.9] Low-Emitting Materials
(g) [CE.2] Support of National Economy
(h) [MO.1] Commissioning Plan
(i) Any other submittal documents that may have changed after Preliminary Review is complete.

4 Based on results of the Final Review, the project will be given a final score and issued a GSAS certification if the constructed project meets or exceeds minimum requirements.

1.2.9 GSAS references:

1 The GSAS references and following compliance are based on the GSAS Version 2.0 – 2013 as the latest GSAS version at the time of Pre-Assessment.

2 A GSAS reference includes the following:

(a) GSAS Training Manual: Commercial & Residential – Part I v2.1.
(b) GSAS Training Manual: Commercial & Residential – Part II v2.1.
(c) GSAS Technical Guide v2.0.
(d) GSAS Energy Application v2.0.
(e) Typologies: GSAS Design Guidelines v2.0.
(f) Typologies: GSAS Design Assessment v2.0.
(g) Health Care: GSAS Design Guidelines v2.0.
(h) Health Care: GSAS Design Assessment v2.0.
(i) Sports: GSAS Design Guidelines v2.0.
(j) Sports: GSAS Design Assessment v2.0.
(k) Typologies: GSAS Operations Guidelines v2.0.
(l) Construction: GSAS Guidelines v2.0.
2. GSAS AND SUSTAINABILITY SCOPE

2.1 GENERAL

1. The contractor has to be responsible to achieve the required GSAS scope and Stars level stipulated in this section and to produce / provide complete documentation, submittals, calculations, data sheets and evidence relevant to the design parameters to the engineer.

2. The project shall be designed and constructed to comply with the scope requirement as stipulated in this section and to achieve a final certification level of 3 Stars.

3. The target scores required for each criterion are subject to GORD final submission stage and approved documentation and shall be updated after the issuance of the 3 stars provisional design certification.

2.2 PROJECT REGISTRATION INFORMATION

1. The project is currently registered with GORD with the following registration details:
   - (a) Project Name: Healthcare Center – Al Khor site.
   - (b) Project ID: PD-QA-0109-0109-PWA
   - (c) Project Address: Plot Pin No. 74112394 , Zone no. 74 .
   - (d) Project Location: Al Khor , Qatar .
   - (e) Gross Area: 29698 m².
   - (f) Gross Floor Area: 11610 m².
   - (g) Car Park Area: 18088 m².
   - (h) Project Site Area: 25000 m².
   - (i) GSAS Scheme: Healthcare
   - (j) Minimum Certification Level: 3 Stars.
   - (k) Current Certification Phase: Pre-Assessment Stage.

2.3 CRITERIA SUMMERY

1. The following scores are the target scores combination required to achieve the 3 stars certification level. The target scores for each criterion are subject to GORD final submission stage and approved documentation and shall be updated after the issuance of the 3 stars provisional design certification:
Preliminary Certification Goal: 3 Stars (★ ★ ★)

<table>
<thead>
<tr>
<th>Urban Connectivity</th>
<th>Targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score</td>
</tr>
<tr>
<td>UC.1: Proximity to Infrastructure</td>
<td>3</td>
</tr>
<tr>
<td>UC.2: Load on Local Traffic Conditions</td>
<td>0</td>
</tr>
<tr>
<td>UC.3: Public Transportation</td>
<td>1</td>
</tr>
<tr>
<td>UC.4: Private Transportation</td>
<td>3</td>
</tr>
<tr>
<td>UC.5: Sewer &amp; Waterway Contamination</td>
<td>3</td>
</tr>
<tr>
<td>UC.6: Acoustic Conditions</td>
<td>0</td>
</tr>
<tr>
<td>UC.7: Proximity to Amenities</td>
<td>2</td>
</tr>
<tr>
<td>UC.8: Accessibility</td>
<td>1</td>
</tr>
<tr>
<td>Urban Connectivity Totals</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Site</th>
<th>Targeted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score</td>
</tr>
<tr>
<td>S.1: Land Preservation</td>
<td>-1</td>
</tr>
<tr>
<td>S.2: Water Body Preservation</td>
<td>3</td>
</tr>
<tr>
<td>S.3: Habitat Preservation</td>
<td>3</td>
</tr>
<tr>
<td>S.4: Vegetation</td>
<td>3</td>
</tr>
<tr>
<td>S.5: Desertification</td>
<td>1</td>
</tr>
<tr>
<td>S.6: Rainwater Runoff</td>
<td>3</td>
</tr>
<tr>
<td>S.7: Heat Island Effect</td>
<td>1</td>
</tr>
<tr>
<td>S.8: Adverse Wind Conditions</td>
<td>3</td>
</tr>
<tr>
<td>S.9: Noise Pollution</td>
<td>-1</td>
</tr>
<tr>
<td>S.10: Light Pollution</td>
<td>3</td>
</tr>
<tr>
<td>Site</td>
<td>Targeted</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>S.11: Shading of Adjacent Properties</td>
<td>3</td>
</tr>
<tr>
<td>S.12: Parking Footprint</td>
<td>-1</td>
</tr>
<tr>
<td>S.13: Shading</td>
<td>0</td>
</tr>
<tr>
<td>S.14: Illumination</td>
<td>3</td>
</tr>
<tr>
<td>S.15: Pathways</td>
<td>3</td>
</tr>
<tr>
<td>Site Totals</td>
<td>28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy</th>
<th>Targeted</th>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.1: Energy Demand Performance</td>
<td>0</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>E.2: Energy Delivery Performance</td>
<td>0</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>E.3: Fossil Fuel Conservation</td>
<td>0</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>E.4: CO2 Emissions</td>
<td>0</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>E.5: NOx, SOx, &amp; Particulate Matter</td>
<td>0</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Energy Totals</td>
<td>0</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water</th>
<th>Targeted</th>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>W.1: Water Consumption</td>
<td>3</td>
<td>0.435</td>
<td></td>
</tr>
<tr>
<td>W.2: Prevention against Legionella</td>
<td>3</td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>Water Totals</td>
<td>6</td>
<td>0.48</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials</th>
<th>Targeted</th>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.1: Regional Materials</td>
<td>1</td>
<td>0.015</td>
<td></td>
</tr>
</tbody>
</table>
### Materials

<table>
<thead>
<tr>
<th>Targeted Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.2: Responsible Sourcing of Materials</td>
<td>3</td>
</tr>
<tr>
<td>M.3: Recycled Materials</td>
<td>1</td>
</tr>
<tr>
<td>M.4: Materials Reuse: Off-Site</td>
<td>-1</td>
</tr>
<tr>
<td>M.5: Structure Reuse</td>
<td>-1</td>
</tr>
<tr>
<td>M.6: Design for Disassembly</td>
<td>2</td>
</tr>
<tr>
<td><strong>Materials Totals</strong></td>
<td><strong>5</strong></td>
</tr>
</tbody>
</table>

### Indoor Environment

<table>
<thead>
<tr>
<th>Targeted Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE.1: Thermal Comfort</td>
<td>-1</td>
</tr>
<tr>
<td>IE.2: Natural Ventilation</td>
<td>-1</td>
</tr>
<tr>
<td>IE.3: Mechanical Ventilation</td>
<td>3</td>
</tr>
<tr>
<td>IE.4: Illumination Levels</td>
<td>3</td>
</tr>
<tr>
<td>IE.5: Daylight</td>
<td>-1</td>
</tr>
<tr>
<td>IE.6: Glare Control</td>
<td>0</td>
</tr>
<tr>
<td>IE.7: Views</td>
<td>0</td>
</tr>
<tr>
<td>IE.8: Acoustic Quality</td>
<td>3</td>
</tr>
<tr>
<td>IE.9: Low-Emitting Materials</td>
<td>1</td>
</tr>
<tr>
<td>IE.10: Indoor Chemical &amp; Pollutant Source Control</td>
<td>3</td>
</tr>
<tr>
<td><strong>Indoor Environment Totals</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

### Cultural & Economic Value

<table>
<thead>
<tr>
<th>Targeted Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE.1: Heritage &amp; Cultural Identity</td>
<td>0</td>
</tr>
<tr>
<td>CE.2: Support of National Economy</td>
<td>3</td>
</tr>
</tbody>
</table>
### Cultural & Economic Value

<table>
<thead>
<tr>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Cultural & Economic Value Totals**

<table>
<thead>
<tr>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.15</td>
</tr>
</tbody>
</table>

### Management & Operations

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>MO.1: Commissioning Plan</td>
<td>3</td>
<td>0.014</td>
</tr>
<tr>
<td>MO.2: Organic Waste Management</td>
<td>3</td>
<td>0.037</td>
</tr>
<tr>
<td>MO.3: Recycling Management</td>
<td>3</td>
<td>0.048</td>
</tr>
<tr>
<td>MO.4: Leak Detection</td>
<td>3</td>
<td>0.009</td>
</tr>
<tr>
<td>MO.5: Energy &amp; Water Use Sub-metering</td>
<td>0</td>
<td>0.000</td>
</tr>
<tr>
<td>MO.6: Automated Control System</td>
<td>3</td>
<td>0.014</td>
</tr>
<tr>
<td>MO.7: Hospitality Management Plan</td>
<td>0</td>
<td>0.000</td>
</tr>
<tr>
<td>MO.8: Sustainability Education &amp; Awareness Plan</td>
<td>3</td>
<td>0.017</td>
</tr>
<tr>
<td>MO.10: Vertical Transportation</td>
<td>3</td>
<td>0.017</td>
</tr>
</tbody>
</table>

**Management & Operations Totals**

<table>
<thead>
<tr>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Overall Totals**

<table>
<thead>
<tr>
<th>Score</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>86</td>
<td>1.32</td>
</tr>
</tbody>
</table>
3. GSAS AND SUSTAINABILITY REQUIREMENTS

3.1 GENERAL

1. This part includes requirements that is mandatory for compliance to be achieved to ensure that GSAS Star Levels and general Sustainability requirements are adhered.

2. The requirements as described in this part shall be read in conjunction with all other relevant sections of the specification.

3. GSAS criteria not indicated in this part is not subject for compliance.

4. The contractor shall provide the engineer with the necessary documentation prior to materials procurement and prior to execution to demonstrate the compliance with the criteria requirement stipulated in this part of this section.

5. The target scores required for each criterion are subject to GORD final submission stage and approved documentation and shall be updated after the issuance of the 3 stars provisional design certification.

6. The contractor/s shall review the design and verify the compatibility of the requirement of this section with the design documents prior to execution and notify the engineer with any adjustment that is required to be developed in order to achieve the GSAS and sustainability requirement. In case any design adjustment or modifications are required, the contractor responsibility is to provide proposed adjusted design to the engineer for approval. In the proposed adjustments, the contractor has to provide design with complete references indicating the changes required to comply with each criterion requirement.

7. It is the contractor/s duty to achieve the required stars level and GSAS scope on the executed works as per the approved final documentation and as specified in accordance with the criteria, standards, requirements and guidelines of GSAS.

3.2 CRITERIA REQUIREMENT

1. The GSAS and sustainability requirements will be mentioned under each applicable related GSAS Criteria as described in part 1 of this section.

3.2.1 Proximity to Infrastructure [UC.1]

1. Description:
   (a) Minimize the amount of new infrastructure construction by selecting a site near available connections to existing infrastructure.

2. Target Score for Compliance:
   (a) 3 (Three).
3 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score.

3.2.2 Public Transportation [UC.3]

1 Description:

(a) Encourage the project to be near access to effective public transportation network in order to reduce private transportation.

2 Target Score for Compliance:

(a) 1 (One).

3 Measurements and Requirements:

(a) The project site is intended to be connected with the RAIL and mowasalat public bus services through a public transport stop located outside the site.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall liaise and coordinate with the client, all relevant statutory authorities, design team, contractor/s and all other bodies as maybe deemed necessary in facilitating the completion of the external public transport stops for the RAIL and mowasalat public bus services.

3.2.3 Private Transportation [UC.4]

1 Description:

(a) The project is implementing strategies to reduce the use of private transportation by providing support facilities for alternative forms of transportation.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) Provide bicycle racks to accommodate at least 10% of the buildings users.

(b) Procurement of any internal vehicles shall be based on a low emissions complying with the latest EPA standards.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
(b) The contractor shall verify that the design documents are in accordance with the criteria requirements or exceeding it prior to execution.

(c) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.4 Sewer & Waterway Contamination [UC.5]

1 Description:

(a) Avoid contamination of waterways to reduce the burden on public treatment facilities.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) Harmful and toxic materials existed on the site shall be collected and removed with means as indicated in the drawings.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall verify that the design documents are in accordance with the criteria requirements or exceeding it prior to execution.

(a) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.5 Acoustic Condition [UC.6]

1 Description:

(a) Minimize the amount of noise exposure within the project's site.

2 Target Score for Compliance:

(a) 0 (Zero).

3 Measurements and Requirements:

(a) Vehicles speed limit within the site shall be limited to 30Km/h.

(b) The Roof Top Package Unit sound pressure level (SPL) at full (100%) load must not exceed 60 dBA at distance of 15 meter.

4 Submittals & Compliance:
(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

### 3.2.6 Proximity to Amenities [UC.7]

1 Description:

(a) The project is implementing strategies to reduce the use of private transportation by providing support facilities for alternative forms of transportation.

2 Target Score for Compliance:

(a) 2 (Two).

3 Measurements and Requirements:

(a) The project will be in near proximity to various types of amenities.

(b) Provide ATM machine as per engineer approval within the project site.

(c) Provide Vendor machine as per engineer approval within the building.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall verify that the design documents are in accordance with the criteria requirements or exceeding it prior to execution.

(c) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

### 3.2.7 Accessibility [UC.8]

1 Description:

(a) Encourage site selection near access to existing pedestrian and bicycle pathway network, as well as intended users.

2 Target Score for Compliance:

(a) 1 (One).

3 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
(a) The contractor shall liaise and coordinate with the client, all relevant statutory authorities and all other bodies as maybe deemed necessary in providing safe off-site pedestrian pathway network leading to the project site.

3.2.8 Land Preservation [S.1]

1 Description:

(a) Preserve the Projects site in its natural state.

2 Measurements and Requirements:

(a) Provide soil erosion control plan and calculation for both short term (during construction) and long term (after project completion).

(b) Ensure stability for earthen embankments including recommendation for maintaining excavation stability (sloping, benching) in light of any potential water erosion hazards if identified at the site.

3 Submittals & Compliance:

(a) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.9 Water Body Preservation [S.2]

1 Description:

(a) Encourage development that prevents or minimizes ecological degradation to water bodies.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) Provide documentation demonstrating that the construction of project site will preserve all existing water bodies and prevent damage or contamination of groundwater.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.
3.2.10 Habitat Preservation [UC.8]

1 Description:
   (a) Encourage development that preserves the biodiversity of the site.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) If habitats including but not limited to mangroves or any natural vegetation existed in the projects site, the contractor shall provide a plan to preserve and relocate them off-site or reuse them on-site.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.11 Vegetation [S.4]

1 Description:
   (a) Minimize and control the use of lawn and specify native and adapted plants that are well suited for hot sub-tropical climates.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) At least 75% of the plants and vegetation must be native/adapted plants for the hot sub-tropical climates as referenced in the Typologies GSAS Design Guidelines v2.0 and its related references.
   (b) No lawn (grass) are permitted to be planted in the project site.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes the criterion requirement prior to execution.
   (c) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.
3.2.12 Desertification [S.5]

1 Description:
   (a) Reserve, prevent, or minimize desertification and protect project site from sandstorms.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) At least 80% of the landscape area shall be protected from desertification through providing proper barriers in accordance with GSAS Training Manual: Commercial & Residential – Part 1 v2.1.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes the criterion requirement prior to execution.
   (c) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.13 Rainwater Runoff [S.6]

1 Description:
   (a) Minimize the amount of rainwater exiting the site by collecting or absorbing any rainwater that falls on the site or building.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) All rainwater that falls on the project’s site shall be collected, treated and stored in a dedicated tank as indicated in the drawings.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes the criterion requirement prior to execution.
(c) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.14 Heat Island Effect [S.7]

1 Description:

(a) Minimize the heat island effect to reduce impact on the surrounding environment.

2 Target Score for Compliance:

(a) 1 (One).

3 Measurements and Requirements:

(a) The external materials shall meet with the following minimum Albedo Value (Solar reflectance Value):

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Minimum Solar Reflectance</th>
<th>Minimum Thermal Emittance</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Roof final layer (white color)</td>
<td>0.70</td>
<td>0.75</td>
</tr>
<tr>
<td>02</td>
<td>Stone Cladding</td>
<td>0.40</td>
<td>n/a</td>
</tr>
<tr>
<td>03</td>
<td>External Paint.</td>
<td>0.75</td>
<td>n/a</td>
</tr>
<tr>
<td>04</td>
<td>Facades Glass Glazing</td>
<td>0.12</td>
<td>n/a</td>
</tr>
<tr>
<td>05</td>
<td>Average of External Hardscape Paving</td>
<td>0.40</td>
<td>n/a</td>
</tr>
<tr>
<td>08</td>
<td>Asphalt For Roads</td>
<td>0.15</td>
<td>n/a</td>
</tr>
<tr>
<td>09</td>
<td>Parking Shed Fabric (Cover)</td>
<td>0.70</td>
<td>n/a</td>
</tr>
</tbody>
</table>

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.
3.2.15 Noise Pollution [S.9]

1 Description:
   (a) Minimize the level of noise produced by the project’s buildings

2 Measurements and Requirements:
   (a) The building envelop solid walls and roofs shall achieve a minimum required STC (sound transmission coefficient) values of 40 STC.
   (b) External Glazing shall achieve a minimum STC (sound transmission coefficient) values of 36 STC.
   (c) All HVAC units shall be acoustically treated with 25mm double skin enclosure with acoustic insulation with minimum density of 48 Kg/m³.

3 Submittals & Compliance:
   (a) The contractor shall submit all the necessary documentation, data sheets, reports, calculations or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.16 Light Pollution [S.10]

1 Description:
   (a) Minimize the amount of light emitted to the exterior from the buildings and its site.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) All vertical illumination levels at each building's site boudary should not exceed the maximum levels specified for each zone under which the buildings are classified per IESNA Lighting Handbook 10th Edition
   (b) All external lighting fixtures that emits lumens at an angle of 90 or higher shall be limited to the maximum allowed % light emission above 90 for street or area lighting for each different environmental zones as stipulated in IESNA Lighting Handbook 10th Edition.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes and comply with the criterion requirement or exceeding it prior to procurement of fixture and execution.
3.2.17 Shading of Adjacent properties [S.12]

1 Description:
   (a) Minimize the shading of adjacent properties.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

3.2.18 Shading [S.13]

1 Description:
   (a) Encourage shading for areas of the site not occupied by buildings or road ways

2 Target Score for Compliance:
   (a) 0 (Zero).

3 Measurements and Requirements:
   (a) All car parking lots must be 100% shaded.
   (b) At least 60% of the pedestrian pathways and common area shall be shaded with landscape or/and architectural elements.

4 Submittals:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes the criterion requirement prior to execution.

3.2.19 Illumination [S.14]

1 Description:
   (a) Ensure that light levels is in line with best practices for visual performance, comfort and safety.

2 Target Score for Compliance:
   (a) 3 (Three).
3. Measurements and Requirements:

(a) All external spaces shall be provided with light levels and uniformity requirements not less than those recommended by the IESNA Lighting Handbook 10th Edition.

(b) The light levels and uniformity shall be limited to 0-10% increase above those recommended by the IESNA Lighting Handbook 10th Edition.

4. Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall verify that the design includes and comply with the criterion requirement or exceeding it prior to procurement of fixture and execution.

(c) The contractor/s shall submit all the necessary documentation, data sheets, reports, or shop drawings if requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.20 Pathways [S.15]

1. Description:

(a) Encourage suitable development with efficient, user friendly pedestrian pathways.

2. Target Score for Compliance:

(a) 3 (Three).

3. Measurements and Requirements:

(a) The buildings in the site plan shall be connected to each other’s with a direct pedestrian pathway with handicapped curb complying with the requirement of the architectural and transportation barriers compliance board & architectural barriers act (ABA) accessibility guidelines for outdoor developed area.

(b) Pathway should feature adequate signage at all intersections and at regular intervals along an unbroken length of a pathway. The following should be included in the signage strategy and layout:

(i) Street signage.

(ii) Pathways labels.

(iii) Directional signs leading to major attractions, parking entrances and exits.

(iv) Safety and advisory warning signs in hazardous and potentially hazardous area.

(v) Signs indicating all public, administrative, and maintenance facilities.

4. Submittals & Compliance:
(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall liaise and coordinate with the design team, contractor/ss and all other bodies as maybe deemed necessary in facilitating the completion of the external works and signage.

(c) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.21 Energy [Part 1 - Building Envelope Requirement]

1 Description:

(a) Establishing energy demand performance and efficient energy delivery in order to reduce the environmental and economic impacts associated with excessive energy use.

2 Target Score for Compliance:

(a) 0 (Zero).

3 Measurements and Requirements:

(a) The Maximum Assembly U-Value (for the entire assembly) for the Building Envelop components shall not exceed the following Table:

<table>
<thead>
<tr>
<th>Final Assembly Maximum U-Value (W/m²k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofs</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>0.23</td>
</tr>
</tbody>
</table>

(a) Glass shading coefficient shall not exceed 0.17.

(b) The overall building envelop heat capacity are categorized as medium heat capacity that shall not exceed 165,000 J/(Km²).

(c) Air leakage for building envelope shall not exceed 0.60 m³/h/m² unless otherwise indicated, to control and minimize air leakage for the entire envelop the following areas of the building envelope shall be sealed, caulked, gasketed, or weather-stripped:

(i) Joints around fenestration and door frames.

(ii) Junctions between walls and foundations, between walls at building corners, between walls and structural floors or roofs, and between walls and roof or wall panels.

(iii) Openings at penetrations of utility services through roofs, walls and floors.

(iv) Site-built fenestration and doors.

(v) Building assemblies used as ducts or plenums.
(vi) Joints, seams, and penetrations of vapor retarders.
(vii) All other openings in the building envelop.
(viii) Fenestration and doors:
  1) Air leakage for fenestration and doors shall be determined in accordance with NFRC 400.
  2) Air leakage rate shall be determined by a laboratory accredited by a national recognized accreditation organization, and shall be labeled and certified by the manufacturer.

2 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes the criterion requirement or exceeding it prior to execution.
   (c) The contractor shall verify through accredited methods that the Final Assembly U_Value is not exceeding the maximum required.
   (d) The contractor shall support the engineer with building envelop air leakage tests determined by a laboratory accredited by a national recognized accreditation organization adhering the requirements mentioned in this criterion or any other relevant sections indicating specific air leakage rates.
   (e) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.22 Energy [Part 2 – MEP & HVAC Requirement]

1 Description:
   (a) Establishing energy demand performance and efficient energy delivery in order to reduce the environmental and economic impacts associated with excessive energy use.

2 Target Score for Compliance:
   (a) 0 (Zero).

3 Measurements and Requirements:
   (a) Provide occupancy and day-lighting sensors as described in the electrical drawings.
   (b) Lighting fixtures average peak power intensity for each typical space shall not exceed 9 W/m².
   (c) All HVAC equipment must utilize environmentally friendly refrigerants.
   (d) All HVAC and mechanical equipment shall meet the minimum efficiency in accordance with ASHRAE 90.1.
(e) Outside flow rate of HVAC equipment shall not exceed a 5% increase on top of the minimum required outside air for each zone as stipulated in ASHRAE 62.1.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall verify that the design includes and comply with the criterion requirement or exceeding it prior to procurement of fixture and execution through calculations, reports, data sheets or simulations.

(c) HVAC equipment environmentally friendly refrigerants shall be supported with third party documentation stating the environmental impact compliance.

(d) The contractor shall verify that all equipment are in accordance with international and local referenced codes and authorities.

(e) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.23 Water Consumption [W.1]

1 Description:

(a) Minimize water consumption in order to minimize the burden on municipal supply and treatment systems.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) The plumbing fixtures shall be classified as low demand types and the typical flow rate shall not exceed the following figures:

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Fixtures</th>
<th>Typical Flow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Metric</td>
</tr>
<tr>
<td>(Male)</td>
<td>Dual Flush Toilet (Male - Low flush)</td>
<td>3.03</td>
</tr>
<tr>
<td></td>
<td>Dual Flush Toilet (Male - Full flush)</td>
<td>6.06</td>
</tr>
<tr>
<td></td>
<td>Low-flow Urinals (Male)</td>
<td>1.89</td>
</tr>
<tr>
<td>(Female)</td>
<td>Dual Flush Toilet (Female - Low Flush)</td>
<td>3.03</td>
</tr>
<tr>
<td></td>
<td>Dual Flush Toilet (Female - Full flush)</td>
<td>6.06</td>
</tr>
<tr>
<td></td>
<td>Flow Fixtures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low-flow Lavatory Sink</td>
<td>1.90</td>
</tr>
</tbody>
</table>
Facilities | Fixtures | Typical Flow rate
--- | --- | ---
 | Metric | Unit | US | Unit
--- | --- | --- | --- | ---
Low-flow Showerhead | 7.50 | lit/min | 2.0 | Gal/min
Low-flow Institution Kitchen Sink | 5.67 | lit/min | 1.5 | Gal/min
Low-flow Institution Janitor Sink | 6.81 | lit/min | 1.8 | Gal/min

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
(b) The contractor shall verify that the design includes and comply with the criterion requirement prior to execution.
(c) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.24 Prevention against Legionella [W.2]

1 Description:

(a) To minimize the risk of legionella contamination in building services.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) A complete water treatment system to prevent legionella shall be provided for hot and cold water systems for the main healthcare building and shall be in compliance with the requirements set out in Part 1 and Part 2 of legionnaire’s Disease—the Control of Legionella Bacteria in Water systems’, Approved Code of Practice and Guidance (ACoP), 3rd Edition 2000, UK Health and Safety Executive.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
(b) The contractor shall provide a sustainable environmental approved system to prevent Legionella provided with third party accreditation including maintenance and operational plan.
(c) The contractor/s shall submit all the necessary documentation, data sheets, reports, or shop drawings if requested by the Engineer for review and approval to support the requirements under this criterion.
3.2.25 Regional Materials [M.1]

1 Description:
   (a) Encourage the use of regionally manufactured and assembled building elements and materials.

2 Target Score for Compliance:
   (a) 1 (One).

3 Measurements and Requirements:
   (a) Contractor/s shall prioritize obtaining as applicable the materials that are regionally (200 Kilometer from site) manufactured or assembled, especially the heavy weighted materials. This includes only the permanently installed material in the project and excludes all mechanical, electrical, plumbing assemblies, specialty items and equipment.
   (b) The regional material is calculated by determining each material weight and the distance from where each material is acquired and it shall follow the following formulas:
      (i) Performance indicator = sum (performance factor) / ((WE + WR) x DR).
      (ii) Where:
         1) Performance factor = ((WE x DE) + (WR x DR)).
         2) WR, is the weight of regional materials in Kilograms (acquired or assembled from distances equal to or less than 200 Km from the project’s site).
         3) WE, is the weight of external materials in Kilograms (acquired or assembled from distances more than 200 Km from the project’s site).
         4) DR, a fixed value of 200 Km which is the maximum distance of the regional materials and are applicable for all distances less than 200 Km.
         5) DE, the distance of where each external material is acquired or assembled (km).
   (c) The Performance indicator of the building shall not exceed 20, and shall be kept lower than this value.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the materials procurement is in compliance with the required performance indicator.
   (c) The contractor shall provide with the supporting documents including the bill of quantities, list of all materials indicating the manufactures / processors, weight of each material, the distance and location from where it is acquired in addition to
the verification of the performance indicator compliance which is the GSAS criterion calculator or any other accepted format of calculation.

3.2.26 Responsible Sourcing of Materials [M.2]

1 Description:

(a) Encourage the use of responsibly sourced materials for primary building elements.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) The Buildings material procurement shall be provided from manufactures with the following certificates:

(i) Environmental Management System (EMS): in accordance with the principle of ISO 14001.

1) At least 50% by cost of the materials permanently installed in the buildings excluding mechanical, electrical, plumbing assemblies, specialty items and equipment must be procured from manufactures holding and complying with this certificate.

(ii) Quality Management System (QMS): in accordance with the standard of ISO 9001.

1) At least 50% by cost of the materials permanently installed in the buildings excluding mechanical, electrical, plumbing assemblies, specialty items and equipment must be procured from manufactures holding and complying with this certificate.

(iii) Timber and wood products:

1) At least 20% of the timbers and wood products used in the buildings should originate from sustainably managed forest and must be supplied by companies the hold Forest Stewardship Council (FSC).

2 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall verify that the materials procurement is in compliance with the required minimum percentages.

(c) The contractor shall submit all the manufacturers certificates along with the materials specifications and data sheets.

(d) The contractor shall provide with the supporting documents including the bill of quantities, list of all materials indicating the manufactures, cost of responsibly sourced materials, and cost of non-responsibly sourced materials in addition to the verification of the total percentage compliance through the GSAS criterion calculator or any other accepted format of calculation.
3.2.27 Recycled Materials [M.3]

1 Description:
   (a) Encourage the use of building elements and materials made from recycled content.

2 Target Score for Compliance:
   (a) 1 (One).

3 Measurements and Requirements:
   (a) The minimum accepted reference for recycled materials content is an equivalent to minimum 10% of the total cost of permanently installed materials shall contain 100% recycled content, this excludes all mechanical, electrical, plumbing assemblies, specialty items, furniture, equipment and installation/labor fees.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the materials procurement is in compliance with the required minimum percentages.
   (c) The contractor shall submit all the materials data sheets indicating the exact amount of recycled/recovered contents.
   (d) The contractor shall provide with the supporting documents including the bill of quantities, list of all materials indicating the manufactures, cost of recycled materials, and recycled content of each material in addition to the verification of the total percentage compliance through the GSAS criterion calculator or any other accepted format of calculation.

3.2.28 Design for Disassembly [M.6]

1 Description:
   (a) Design building elements and materials for ease of disassembly.

2 Target Score for Compliance:
   (a) 2 (Two).

3 Measurements and Requirements:
   (a) The shop drawings shall take into consideration that at least 30% of buildings permanently installed materials cost should have the ability to be easily disassembled and separated if needed. Excluded from this criterion are all mechanical, electrical, plumbing assemblies, specialty items, furniture, equipment.

4 Submittals & Compliance:
(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall provide the shop drawings with illustration/details of the disassembly ability to the permanently installed materials including but not limited to external cladding and building envelop, internal cladding, suspended ceiling, raised floors, internal partitions.

3.2.29 Thermal Comfort [IE.1]

1 Description:
(a) Provide a thermally comfortable environment.

2 Measurements and Requirements:
(a) Building envelop shall strictly comply with requirement stipulated in this section under Energy (part1-Building Envelop requirement).
(b) Air outlets velocities shall be in accordance with the HVAC design and shall not exceed what stipulated in ASHRAE Handbook.
(c) Indoor design air temperature must be achieved consistently within the space.

3 Submittals & Compliance:
(a) The contractor shall verify the design calculation prior to equipment procurement.
(b) The contractor shall ensure through design verification and further calculation that the indoor temperature will meet the design set temperature.
(c) The contractor shall submit to the engineer as required all the required analysis, calculations, and equipment data sheet.

3.2.30 Mechanical Ventilation [IE.3]

1 Description:
(a) Provide effective mechanical ventilation.

2 Target Score for Compliance:
(a) 3 (Three).

3 Measurements and Requirements:
(a) Mechanical equipment must meet the minimum efficiency standard as stipulated in ASHRAE 90.1.
(b) Outside flow rate must be limited to a maximum of 5% increase on top of the minimum required outside air for each zone as stipulated in ASHRAE 62.1.
(c) Mechanical ventilation equipment must utilize heat recovery between extracted air and fresh air.

4 Submittals & Compliance:
(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
(b) The contractor shall verify that the design includes and comply with the criterion requirement prior to execution.
(c) The contractor shall comply with the minimum equipment efficiencies.
(d) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings if requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.31 Illumination Levels [IE.4]

1 Description:
   (a) Ensure that light levels is in line with best practices for visual performance, comfort and safety.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) All spaces must meet the IESNA Lighting Handbook minimum illuminance level and uniformity requirement.
   (b) The illuminance levels in all building's spaces are limited to a maximum of 10% increase above the minimum recommended illuminance levels by the IESNA Lighting Handbook.

4 Submittals:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes and comply with the criterion requirement or exceeding it prior to procurement of fixture and execution through calculations, reports, data sheets or simulations.
   (c) The contractor shall comply with the minimum lighting levels range permitted above.
   (d) The contractor shall submit all the necessary documentation, data sheets, reports, or shop drawings if requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.32 Glare Control [IE.6]

1 Description:
   (a) Minimize direct or reflected glare within occupied spaces.

2 Target Score for Compliance:
3 Measurements and Requirements:
   (a) All occupied spaces with external glazing / windows must be equipped with internal curtains as approved by the engineer.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes and comply with the criterion requirement prior to execution.

3.2.33 Views [IE.6]

1 Description:
   (a) Provide occupants with access to external views

2 Target Score for Compliance:
   (a) 0 (Zero).

3 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes and comply with the criterion requirement prior to execution.

3.2.34 Acoustic Quality [IE.8]

1 Description:
   (a) All building’s elements shall meet the minimum requirements for acoustic quality.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) The indoor noise level must meet the recommended noise levels as described in the tables below:
<table>
<thead>
<tr>
<th>Room Type</th>
<th>Example</th>
<th>Criteria for noise intrusion to be met inside the spaces from external sources (dB)</th>
</tr>
</thead>
</table>
| Ward - single person              | Single-bed ward, single-bed recovery areas and on-call room, relatives' overnight stay | 40L_{Aeq} 1hr_{daytime}  
35L_{Aeq} 1hr_{night}  
45L_{Amax} f_{night} |
| Ward - multi-bed                  | Multi-bed wards, recovery areas                                         | 45L_{Aeq} 1hr_{daytime}  
35L_{Aeq} 1hr_{night}  
45L_{Amax} f_{night} |
| Small office-type spaces          | Private offices, small treatment rooms, interview rooms, consulting rooms | 40L_{Aeq} 1hr                                                                 |
| Open clinical areas               | A&E                                                                    | 45L_{Aeq} 1hr                                                                 |
| Circulation spaces                | Corridors, hospital street, Atria                                       | 55L_{Aeq} 1hr                                                                 |
| Public areas                      | Dining areas, waiting areas, playrooms                                  | 50L_{Aeq} 1hr                                                                 |
| Personal hygiene (en-suite)       | Toilets, Showers                                                        | 45L_{Aeq} 1hr                                                                 |
| Personal hygiene (public and staff)| Toilets, Showers                                                        | 55L_{Aeq} 1hr                                                                 |
| Small food preparation areas       | Ward kitchens                                                           | 50L_{Aeq} 1hr                                                                 |
| Large food preparation areas       | Main kitchens                                                           | 55L_{Aeq} 1hr                                                                 |
| Large meeting rooms (>35 m² floor area) | Lecture theatres, meeting rooms, board rooms, seminar rooms, classrooms | 35L_{Aeq} 1hr                                                                 |
| Small meeting rooms (≤35 m² floor area) | Meeting rooms, seminar rooms, classrooms, board rooms | 40L_{Aeq} 1hr                                                                 |
| Operating Theatres                | Operating theatres                                                     | 40L_{Aeq} 1hr  
50L_{Amax} f'' |
| Laboratories                      | Laboratories                                                           | 45L_{Aeq} 1hr                                                                 |
### Table 2 Criteria for Internal Noise from Mechanical and Electrical Services

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Example</th>
<th>Noise from mechanical and electrical services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ward areas, sleeping areas</td>
<td>&quot;Single-bed ward, single-bed recovery areas and on-call room, relatives' overnight stay Recovery rooms&quot;</td>
<td>NR 30, NR 35</td>
</tr>
<tr>
<td>Small office-type spaces</td>
<td>Private offices, small treatment rooms, interview rooms, consulting rooms</td>
<td>NR 35</td>
</tr>
<tr>
<td>Open clinical areas</td>
<td>A&amp;E</td>
<td>NR 40</td>
</tr>
<tr>
<td>Circulation spaces</td>
<td>Corridors, hospital street, atria</td>
<td>NR 40</td>
</tr>
<tr>
<td>Public areas</td>
<td>Dining areas, waiting areas, playrooms</td>
<td>NR 40</td>
</tr>
<tr>
<td>Personal hygiene (en-suite)</td>
<td>Toilets, showers</td>
<td>NR 40</td>
</tr>
<tr>
<td>Personal hygiene (general access)</td>
<td>Toilets, Showers</td>
<td>NR 45</td>
</tr>
<tr>
<td>Small food preparation areas</td>
<td>Ward kitchens</td>
<td>NR 40</td>
</tr>
<tr>
<td>Large food preparation areas</td>
<td>Main kitchens</td>
<td>NR 50 (NR 55 below extract hoods)</td>
</tr>
<tr>
<td>Large meeting rooms (&gt;35 m² floor area)</td>
<td>Lecture theatres, meeting rooms, board rooms, seminar rooms, classrooms</td>
<td>NR 30</td>
</tr>
<tr>
<td>Small meeting rooms (≤35 m² floor area)</td>
<td>Meeting rooms, seminar rooms, classrooms, board rooms</td>
<td>NR 35</td>
</tr>
<tr>
<td>Operating Theatres (excluding laminar-flow theatres)</td>
<td>Operating theatres</td>
<td>NR 40</td>
</tr>
<tr>
<td>Laminar-flow theatres</td>
<td>Ultra-clean theatre</td>
<td>NR 50</td>
</tr>
<tr>
<td>Laboratories</td>
<td>Laboratories</td>
<td>NR 40 when laboratory has no fume cupboards NR 60 at 1m from fume cupboards with open sash</td>
</tr>
<tr>
<td>Utility Rooms</td>
<td>Clean utility, dirty utility</td>
<td>NR 40</td>
</tr>
</tbody>
</table>
Table 3 Sound Insulation Parameters of Rooms, Part I

<table>
<thead>
<tr>
<th>Room</th>
<th>Privacy requirements for source room</th>
<th>Noise generation of the source room</th>
<th>Noise sensitivity of receiving room</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical Areas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-bed/on-call room</td>
<td>Confidential</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Multi-bed room</td>
<td>Moderate</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Children &amp; older people</td>
<td>Private</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>(single bed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children &amp; older people</td>
<td>Moderate</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>(multi-bed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consulting room</td>
<td>Confidential</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Examination room</td>
<td>Confidential</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Treatment room</td>
<td>Confidential</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Counseling/bereavement room</td>
<td>Confidential</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Interview Room</td>
<td>Confidential</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Operating theatre suite</td>
<td>Private</td>
<td>Typical</td>
<td>Sensitive</td>
</tr>
<tr>
<td>Nurseries</td>
<td>Moderate</td>
<td>Very High</td>
<td>Medium</td>
</tr>
<tr>
<td>Birthing room</td>
<td>Private</td>
<td>Very High</td>
<td>Medium</td>
</tr>
<tr>
<td>Laboratories</td>
<td>Moderate</td>
<td>Typical</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Dirty utility/sludge</td>
<td>Not Private</td>
<td>High</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Clean utility</td>
<td>Not Private</td>
<td>Low</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Speech and language therapy</td>
<td>Confidential</td>
<td>High</td>
<td>Sensitive</td>
</tr>
<tr>
<td>Snoezelen multi-sensory room</td>
<td>Confidential</td>
<td>High</td>
<td>Sensitive</td>
</tr>
<tr>
<td><strong>Public areas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-faith/chapel</td>
<td>Private</td>
<td>High</td>
<td>Sensitive</td>
</tr>
<tr>
<td>Corridor (no door)</td>
<td>Not Private</td>
<td>Typical</td>
<td>Not Sensitive</td>
</tr>
<tr>
<td>Atrium</td>
<td>Not Private</td>
<td>High</td>
<td>Not Sensitive</td>
</tr>
</tbody>
</table>

Table 3 Sound Insulation Parameters of Rooms, Part II

<table>
<thead>
<tr>
<th>Room</th>
<th>Privacy requirements for source room</th>
<th>Noise generation of the source room</th>
<th>Noise sensitivity of receiving room</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dining</strong></td>
<td>Not Private</td>
<td>High</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Toilets (not cubicles)</td>
<td>Moderate</td>
<td>Typical</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Waiting (large &gt;20 people)</td>
<td>Not Private</td>
<td>High</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Waiting (small ≤20 people)</td>
<td>Not Private</td>
<td>Typical</td>
<td>Not sensitive</td>
</tr>
<tr>
<td><strong>Staff areas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room</td>
<td>Privacy requirements for source room</td>
<td>Noise generation of the source room</td>
<td>Noise sensitivity of receiving room</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------------------------------</td>
<td>-------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Toilets (not cubicles)</td>
<td>Moderate</td>
<td>Typical</td>
<td>Not Sensitive</td>
</tr>
<tr>
<td>Main kitchen</td>
<td>Not Private</td>
<td>Very High</td>
<td>Not Sensitive</td>
</tr>
<tr>
<td>Ward kitchens, pantry</td>
<td>Not Private</td>
<td>Typical</td>
<td>Not Sensitive</td>
</tr>
<tr>
<td>Store room</td>
<td>Not Private</td>
<td>Low</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Rest room</td>
<td>Moderate</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Locker/changing room</td>
<td>Moderate</td>
<td>Typical</td>
<td>Not sensitive</td>
</tr>
<tr>
<td>Large training/seminar (&gt;35 m²)</td>
<td>Private</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Small training/seminar (≤35 m²)</td>
<td>Private</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Lecture theatre</td>
<td>Private</td>
<td>High</td>
<td>Sensitive</td>
</tr>
<tr>
<td>Library/archiving room</td>
<td>Moderate</td>
<td>Low</td>
<td>Sensitive</td>
</tr>
<tr>
<td>Single-person office</td>
<td>Private</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Multi-person office (2-4 people)</td>
<td>Moderate</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Open-plan office (25 people)</td>
<td>Not Private</td>
<td>Typical</td>
<td>Medium</td>
</tr>
<tr>
<td>Boardroom</td>
<td>Confidential</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Large meeting room (&gt;35 m²)</td>
<td>Private</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Small meeting room (≤35 m²)</td>
<td>Private</td>
<td>Typical</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Table 4 Sound Insulation Parameters of Rooms

<table>
<thead>
<tr>
<th>Privacy Requirements For Source Room</th>
<th>Noise Generation Of The Source Room</th>
<th>Noise Sensitivity Of Receiving Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidential</td>
<td>Very High</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Typical</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Sensitive</td>
<td>é</td>
</tr>
<tr>
<td></td>
<td></td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47</td>
</tr>
</tbody>
</table>
(b) Internal doors must achieve the minimum sound transmission class (STC) as indicated in the drawings and schedules.

(c) Internal walls and partitions must achieve the minimum sound transmission class (STC) as indicated in the drawings.

(d) Provide at least 80% coverage of the floor area with a class C absorber (NRC of minimum 0.60) in all occupied spaces including corridors except for the non-sensitive spaces as indicated above.

(e) A minimum 5mm resilient layer must be installed above structure slab below finishing layers for all sensitive spaces.

The resilient layer should provide an improvement in impact insulation class when installed with the final floor finish as given in the table below for the varying thickness of concrete slab.

<table>
<thead>
<tr>
<th>Slab Thickness Range (mm)</th>
<th>Δ IIC Rating (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 - 180</td>
<td>25</td>
</tr>
<tr>
<td>190 - 260</td>
<td>20</td>
</tr>
<tr>
<td>270 - 350</td>
<td>15</td>
</tr>
</tbody>
</table>
(f) HVAC package units must be provided with sound attenuator at supply and return duct work as referenced in the drawings and on section 22.

(g) All internal Concealed must be acoustically treated to limit the sound power level to the values indicated and mentioned on section 22.

(h) MEP and HVAC Equipment mountings including but not limited to Generators, pumps, HVAC units, fans and miscellaneous. Shall be supported and equipped with vibration isolation as recommended by manufacturer and as indicated to eliminate and prevent vibrations.

(i) All services penetration shall be acoustically treated and sealed and supported with materials data sheets indicating the acoustical performance.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) Reverberation time tests shall be carried out by an acoustic consultant (preferably a member of the Middle East Acoustics Society) in accordance with BS EN ISO 3382-2:2008 Acoustics – Measurement of room acoustic parameters – Part 2: Reverberation time in ordinary rooms.

(c) The contractor shall comply with all minimum Sound transmission coefficient (STC) as indicated in the drawings for internal walls and partitions.

(d) The contractor shall ensure that all internal partitions except for internal toilet compartments are extended from slab to slab.

(e) All building element submissions must be supported with acoustic test reports undertaken in a suitably accredited (UKAS or equal and approved) laboratory. Test must be undertaken in accordance with ASTM E90-09 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partition and Elements. Results must be presented in accordance with ASTM E413-10.

(f) All door and window submissions must be supported with acoustic test reports undertaken in a suitably accredited (UKAS or equal and approved) laboratory. Test must be undertaken in accordance with ASTM E90-09 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partition and Elements. Results must be presented in accordance with ASTM E413-. Tests on doors and windows shall be undertaken on the building element including the frames and seals as specified for the project.

(g) All acoustic ceiling submissions must be supported with acoustic test reports undertaken in a suitably accredited (UKAS or equal and approved) laboratory. Test must be undertaken in accordance with ASTM C423-09a Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

(h) Where an isolated screed is required, the isolating membrane shall be tested in accordance with ASTM E989-06(2012) Standard Classification for Determination of Impact Insulation Class (IIC).

(i) All glass and glazing submissions must be supported with acoustic test reports undertaken in a suitably accredited (UKAS or equal and approved) laboratory.
Test must be undertaken in accordance with ASTM E90-09 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partition and Elements. Results must be presented in accordance with ASTM E413-10.

(j) The contractor shall verify that the design includes and comply with the criterion requirement or exceeding it prior to procurement of products and execution through calculations, reports, data sheets or simulations.

(k) The contractor shall verify that all equipment are in accordance with international and local referenced codes and authorities.

(l) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.35 Low-Emitting Materials [IE.9]

1 Description:

(a) Meet minimum emissions targets for indoor materials and finishes.

2 Target Score for Compliance:

(a) 1 (One).

3 Measurements and Requirements:

(a) All internal materials and finishes are preferably being selected with no VOCs (Volatile Organic Compounds) and if necessary, VOCs content in (g/L less water) shall not exceed the following contents:

<table>
<thead>
<tr>
<th>Material Type</th>
<th>VOC Maximum Limit (g/L less water)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adhesives and sealants</strong></td>
<td></td>
</tr>
<tr>
<td>Indoor Carpet Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>Carpet Pad Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>Outdoor Carpet Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>Wood Flooring Adhesives</td>
<td>30</td>
</tr>
<tr>
<td>Rubber Floor Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>Ceramic Tile Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>VCT and Asphalt Tile Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>Dry Wall and Panel Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>Cove Base Adhesives</td>
<td>20</td>
</tr>
<tr>
<td>Material Type</td>
<td>VOC Maximum Limit (g/L less water)</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Multipurpose Construction Adhesives</td>
<td>40</td>
</tr>
<tr>
<td>Structural Glazing Adhesives</td>
<td>50</td>
</tr>
<tr>
<td>Single Ply Roof Membrane Adhesives</td>
<td>150</td>
</tr>
<tr>
<td><strong>Substrate Specific Applications</strong></td>
<td></td>
</tr>
<tr>
<td>Metal to Metal</td>
<td>30</td>
</tr>
<tr>
<td>Plastic Foams</td>
<td>50</td>
</tr>
<tr>
<td>Porous Material (except wood)</td>
<td>50</td>
</tr>
<tr>
<td>Wood</td>
<td>30</td>
</tr>
<tr>
<td>Fiberglass</td>
<td>80</td>
</tr>
<tr>
<td><strong>Specialty Applications</strong></td>
<td></td>
</tr>
<tr>
<td>PVC Welding</td>
<td>510</td>
</tr>
<tr>
<td>CPVC Welding</td>
<td>490</td>
</tr>
<tr>
<td>ABS Welding</td>
<td>325</td>
</tr>
<tr>
<td>Plastic Cement Welding</td>
<td>250</td>
</tr>
<tr>
<td>Adhesive Primer for Plastic</td>
<td>550</td>
</tr>
<tr>
<td>Computer Diskette Manufacturing</td>
<td>350</td>
</tr>
<tr>
<td>Contact Adhesive</td>
<td>80</td>
</tr>
<tr>
<td>Special Purpose Contact Adhesive</td>
<td>250</td>
</tr>
<tr>
<td>Tire Retread</td>
<td>100</td>
</tr>
<tr>
<td>Adhesive Primer for Traffic Marking Tape</td>
<td>150</td>
</tr>
<tr>
<td>Structural Wood Member Adhesive</td>
<td>140</td>
</tr>
<tr>
<td>Sheet Applied Rubber Lining Operations</td>
<td>850</td>
</tr>
<tr>
<td>Top and Trim Adhesive</td>
<td>250</td>
</tr>
<tr>
<td><strong>Sealants</strong></td>
<td></td>
</tr>
<tr>
<td>Architectural</td>
<td>70</td>
</tr>
<tr>
<td>Marine Deck</td>
<td>760</td>
</tr>
<tr>
<td>Non-membrane Roof</td>
<td>180</td>
</tr>
<tr>
<td>Roadway</td>
<td>150</td>
</tr>
<tr>
<td>Single-Ply Roof Membrane</td>
<td>270</td>
</tr>
<tr>
<td><strong>Sealant Primers</strong></td>
<td></td>
</tr>
<tr>
<td>Architectural Non Porous</td>
<td>70</td>
</tr>
<tr>
<td>Architectural Porous</td>
<td>540</td>
</tr>
</tbody>
</table>
## Table No. 1_VOC Maximum limit

<table>
<thead>
<tr>
<th>Material Type</th>
<th>VOC Maximum Limit (g/L less water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Bituminous</td>
<td>500</td>
</tr>
<tr>
<td>Marine Deck</td>
<td>760</td>
</tr>
</tbody>
</table>

### 2. Aerosol adhesives

- General purpose mist spray                                   | 65% VOCs by weight                 |
- General purpose web spray                                     | 55% VOCs by weight                 |
- Special purpose aerosol adhesives (all types)                 | 70% VOCs by weight                 |

### 3. Paints, coatings, and primers

- Flat Topcoat                                                  | 10                                 |
- Non-Flat Topcoat                                              | 50                                 |
- Primer or Undercoat                                            | 50                                 |
- Floor Paint                                                    | 20                                 |
- Anti-Corrosive Coating                                         | 150                                |
- Reflective Wall Coating                                       | 90                                 |
- Reflective Roof Coating                                       | 50                                 |
- Flat Topcoat with colorant added at the point-of-sale         | 50                                 |
- Non-Flat Topcoat with colorant added at the point-of-sale     | 90                                 |
- Primer or Undercoat with colorant added at the point-of-sale  | 90                                 |
- Floor Paint with colorant added at the point-of-sale          | 90                                 |
- Anti-Corrosive Coating with colorant added at the point-of-sale | 300                               |
- Reflective Wall Coating with colorant added at the point-of-sale | 60                                 |
- Reflective Roof Coating with colorant added at the point-of-sale | 75                                 |

### 4. Clear wood finishes, floor coating, stains, sealers, and shellacs

- Bond Breakers                                                 | 350                                |
- Clear Wood Finishes                                           | 275                                |
- Varnish                                                       | 275                                |
- Sanding Sealers                                               | 275                                |
- Lacquer                                                       | 275                                |
- Clear Brushing Lacquer                                        | 275                                |
- Concrete-Curing Compounds                                     | 275                                |
- Concrete-Curing Compounds For Roadways and Bridges            | 60                                 |
- Concrete-Curing Compounds                                     | 350                                |
### Table No. 1_VOC Maximum limit

<table>
<thead>
<tr>
<th>Material Type</th>
<th>VOC Maximum Limit (g/L less water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry-Fog Coatings</td>
<td>400</td>
</tr>
<tr>
<td>Fire-Proofing Exterior Coatings</td>
<td>350</td>
</tr>
<tr>
<td>Flats</td>
<td>20</td>
</tr>
<tr>
<td>Floor Coatings</td>
<td>20</td>
</tr>
<tr>
<td>Graphic Arts(sign) Coatings</td>
<td>500</td>
</tr>
<tr>
<td>Industrial Maintenance (IM) Coatings</td>
<td>50</td>
</tr>
<tr>
<td>High Temperature IM Coatings</td>
<td>420</td>
</tr>
<tr>
<td>Zinc-Rich IM Primers</td>
<td>100</td>
</tr>
<tr>
<td>Japans/Faux Finishing Coatings</td>
<td>350</td>
</tr>
<tr>
<td>Magnesite Cement Coatings</td>
<td>450</td>
</tr>
<tr>
<td>Mastic Coatings</td>
<td>300</td>
</tr>
<tr>
<td>Metallic Pigmented Coatings</td>
<td>500</td>
</tr>
<tr>
<td>Multi-Color Coatings</td>
<td>250</td>
</tr>
<tr>
<td>Non-flat Coatings</td>
<td>20</td>
</tr>
<tr>
<td>Non-flat High Gloss</td>
<td>20</td>
</tr>
<tr>
<td>Pigmented Lacquer</td>
<td>275</td>
</tr>
<tr>
<td>Pre-Treatment Wash Primers</td>
<td>420</td>
</tr>
<tr>
<td>Primers, Sealers, and Under coaters</td>
<td>50</td>
</tr>
<tr>
<td>Quick-Dry Enamels</td>
<td>30</td>
</tr>
<tr>
<td>Quick-Dry Primers, Sealers, and Under coaters</td>
<td>50</td>
</tr>
<tr>
<td>Recycled Coatings</td>
<td>250</td>
</tr>
<tr>
<td>Roof Coatings</td>
<td>50</td>
</tr>
<tr>
<td>Roof Coatings, Aluminium</td>
<td>100</td>
</tr>
<tr>
<td>Roof Primers, Bituminous</td>
<td>350</td>
</tr>
<tr>
<td>Rust Preventative Coatings</td>
<td>100</td>
</tr>
<tr>
<td>Shellac Clear</td>
<td>730</td>
</tr>
<tr>
<td>Shellac Pigmented</td>
<td>550</td>
</tr>
<tr>
<td>Swimming Pool Coatings Repair</td>
<td>340</td>
</tr>
<tr>
<td>Swimming Pool Coatings Other</td>
<td>340</td>
</tr>
<tr>
<td>Traffic Coatings</td>
<td>100</td>
</tr>
<tr>
<td>Waterproofing Sealers</td>
<td>400</td>
</tr>
<tr>
<td>Waterproofing Concrete/Masonry Sealers</td>
<td>400</td>
</tr>
</tbody>
</table>
Table No. 1_VOC Maximum limit

<table>
<thead>
<tr>
<th>Material Type</th>
<th>VOC Maximum Limit (g/L less water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Preservatives Below-Ground</td>
<td>350</td>
</tr>
<tr>
<td>Wood Preservatives Other</td>
<td>350</td>
</tr>
</tbody>
</table>

4 Submittals:

(a) The contractor shall comply with the final approved GSAS submittals, documentation and anticipated score when provided.

(b) The contractor shall verify that the materials procurement is in compliance with the required minimum contents.

(c) The contractor shall submit to the engineer all internal materials data sheets indicating the exact amount of VOCs (Volatile Organic Compounds).

3.2.36 Indoor Chemical & Pollutant Source Control [IE.10]

1 Description:

(a) Minimize potentially hazardous airborne contaminants affecting building occupants.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) All regular entrances shall incorporate floor mats/grills.

(b) All internal partitions except for internal toilet compartments shall be extended from slab to slab.

(c) Separate exhaust system shall be provided in all spaces with potential contaminants.

4 Submittals & Compliance:

(a) The contractor shall verify that the design includes and comply with the criterion requirement or exceeding it prior to execution.

(b) The contractor shall verify that all equipment are in accordance with international and local referenced codes and authorities.

(c) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.37 Heritage & Cultural Identity [CE.1]

1 Description:
(a) Encourage design expression that will align with and strengthen cultural identity and traditions

2 Target Score for Compliance:

(a) 0 (Zero).

3 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

### 3.2.38 Support of National Economy [CE.2]

1 Description:

(a) Maximize the percentage of construction expenditures for goods and services originating from the national economy.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) The percentage of construction expenditure for services and goods originating from the national economy, this includes labors, contractor/s, building materials, construction materials, construction equipment, etc. shall be at least 30% of the total construction cost.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall provide a report outlining the contractual setup for construction expenditure, inventory of all materials and a comprehensive list of construction expenditure with associated costs highlighting the achievement of the required percentage prior to proceeding with the construction.

### 3.2.39 Commissioning Plan [MO.1]

1 Description:

(a) Encourage commissioning planning within the design process.

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:
(a) The owner representative will appoint an independent third-party commissioning authority to develop commissioning process through construction phase to ensure proper design, construction, calibration and performance of all buildings systems.

(b) The following building systems will be under the scope of commissioning:

(i) Life safety systems.
(ii) HVAC systems.
(iii) Electrical Systems.
(iv) Building Envelope.
(v) Water-Use Systems.
(vi) Renewable energy systems.
(vii) Security systems.
(viii) Large-scale food service equipment.
(ix) Large-scale broadcast and media systems.

(c) The Commissioning Authority will be responsible for overseeing and coordinating the following issues during the commissioning process:

(i) Updating and reviewing a plan that outlines the owner’s commissioning goals and objectives.
(ii) Updating and reviewing of a plan by the design team that delineates standards and descriptions for all commissioned systems.
(iii) Verification of commissioning requirements within the construction documents.
(iv) Review and verification of performance results of commissioned building systems, and completion of a summary commissioning report.

4 Submittals & Compliance:

(a) The contractor shall liaise and coordinate with the client, design team, contractor/s and all other bodies as maybe deemed necessary to facilitate the commissioning process.

3.2.40 Organic Waste Management [MO.2]

1 Description:

(a) Encouraging planning for the collection of organic waste

2 Target Score for Compliance:

(a) 3 (Three).

3 Measurements and Requirements:

(a) The project will provide a plan to segregate, collect, store and remove Organic Waste Off-site.
4 Submittals & Compliance:
(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

3.2.41 Recycling Management [MO.3]

1 Description:
(a) Encouraging planning for the segregation and collection of recyclable waste

2 Target Score for Compliance:
(a) 3 (Three).

3 Measurements and Requirements:
(a) The project will provide a plan to segregate, collect, store and remove Organic Waste Off-site.

4 Submittals & Compliance:
(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

3.2.42 Leak Detection [MO.4]

1 Description:
(a) Minimize the impact of major water leakage.

2 Target Score for Compliance:
(a) 3 (Three).

3 Measurements and Requirements:
(a) Leak detection system is installed in all water supply and wet area of the building and consists of a monitor unit, sensor cable and interface modules and provided with alarm giving an accurate location of the leak.

4 Submittals & Compliance:
(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
(b) The contractor shall verify that the design includes and comply with the criterion requirement prior to execution.
(c) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.
3.2.43 Automated Control Systems [MO.6]

1 Description:
   (a) Encourage the installation of an Automated Control System

2 Target Score for Compliance:
   (a) 3 (Three).

3 Measurements and Requirements:
   (a) A centralized automated monitoring and control system are integrated to the mechanical and electrical systems; the system is designed to indicate the performance of the connected systems in accordance with the preset criteria to give commands for actions as programmed.

4 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.
   (b) The contractor shall verify that the design includes and comply with the criterion requirement prior to execution.
   (c) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.

3.2.44 Sustainability Education & Awareness Plan [MO.8]

1 Description:
   (a) Encourage projects to promote and educate users, visitors, and local community members about sustainable initiatives and programs associated with the facility.

2 Target Score for Compliance:
   (a) 3 (Three).

3 Submittals & Compliance:
   (a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

3.2.45 Vertical Transportation [MO.10]

1 Description:
   (a) Encourage projects to reduce energy consumption through efficient lifts.

2 Target Score for Compliance:
   (a) 3 (Three).
3 Measurements and Requirements:

(a) Lifts shall be equipped with a stand-by mode operation that shall switch off the cab lights, indicators whenever the elevator is unused for a pre-set period of time.

(b) Lifts cab shall be equipped with high efficient LED lighting fixtures.

4 Submittals & Compliance:

(a) The contractor shall comply with the final approved GSAS submittals, documentations and anticipated score when provided.

(b) The contractor shall verify that the design includes and comply with the criterion requirement prior to execution.

(c) The contractor shall submit all the necessary documentation, data sheets, reports, calculations, or shop drawings as requested by the Engineer for review and approval to support the requirements under this criterion.
4. CONSTRUCTION GUIDELINES

4.1 GENERAL

1. The client shall appoint GSAS-CGP (Green Certified Professional) authorized representative with a valid certificate from GORD to lead the overall planning, scheduling, and coordinating of the required GSAS requirements and construction inspections and

2. The contractor shall assign a GSAS-CGP (Green Certified Professional) with a valid certificate from GORD to develop a comprehensive report prior to construction and materials / equipment procurement. The report shall highlight the contractor’s strategy in complying with the GSAS and sustainability requirement and demonstrating full compliance to the GSAS and sustainability scope and each criterion objective and to be presented to the client representative and/or the engineer for approval.

3. The contractor GSAS-CGP shall lead a staff with expertise covering all trades required in the project to verify the design in accordance with the GSAS and sustainability requirement and to develop proposals and/or specifying any upgrades in the design if needed to maintain and achieve the required stars level assigned for each building.

4. The contractor has to be responsible to achieve the required GSAS scope and Stars level and ensure complete and full compliance of the project and all his activities on site to the GSAS and sustainability requirement provided in this section and referenced in GORD guidelines and manuals and to produce / provide complete documentation, submittals, calculations, data sheets and evidence relevant to the design parameters to the client representative.

5. In case any design adjustment or modification are required to achieve the GSAS / sustainability requirement the contractor responsibility is to provide proposed adjusted design to the engineer for approval. In the proposed adjustments, the contractor has to provide design with complete references indicating the changes required to comply with each criterion requirement.

6. The contractor while carrying out his duties shall assume complete ownership to the design documents and maintain the projects objective in achieving sustainable development in accordance with the GSAS with all background and proof documentation to the satisfaction of the engineer.

7. The contractor shall provide the engineer with the necessary documentation prior to materials procurement and prior to execution to demonstrate the compliance with the criteria requirement stipulated in part 3 of this section.it shall be the contractor duty to achieve the required scope on the executed works in accordance with the criteria, standards set by GORD.

8. The contractor shall provide periodical reports to the engineer as maybe required to present the status of the GSAS implementation related to each criterion in the shop drawings, material selection, material procurement, construction waste management,
or any other sustainable activities needed to complete the GSAS and sustainability scope set for this project.

9 The contractor shall perform or/and provide any tests required by the consultant/engineer to prove any values required in the specification such as but not limited to Solar reflectance, VOC’s, STC’s, NRC’s.

10 No changes to fees or time shall be allowed to the contractor at any time of the project execution to cover all of the above and maintain the project sustainability objectives.

11 The contractor shall comply with all the specifications, calculations and values required in all GSAS criteria to meet the targeted Stars Level.

12 The contractor shall comply with all approved sustainable requirements for products, installation waste management, execution and all site works.

13 Contractor shall implement a construction waste recycle plan and present it to the engineer for review and approval.

14 To obtain acceptable Indoor Air Quality and to minimize the environmental impacts of the construction and operation, the Contractor during the construction phase of this project shall implement the following procedures singly or in combination:

(a) Select products that minimize consumption of non-renewable resources consume reduced amounts of energy and minimize amounts of pollution to produce, and employ recycled and/or recyclable materials.

(i) Include environmental considerations as part of the normal purchasing process.

(ii) Emphasize pollution prevention early in the purchasing process.

(iii) Examine multiple environmental attributes throughout a product’s or service’s life cycle.

(iv) Compare relevant environmental impacts when selecting products and services.

(v) Collect and base purchasing decisions on accurate and meaningful information about environmental performance.

(b) Control sources for potential Indoor Air Quality pollutants by controlled selection of materials and processes used in project construction in order to attain superior Indoor Air Quality.
SECTION 8

SEWERAGE
3. Pipes and Fittings Materials

*Delete sub clauses 3.3, and 3.4.*
9. Trenchless Pipeline Construction

*Delete all sub clauses /item.*
11. Sewer Rehabilitation

Delete all sub clauses /item.
12. Vacuum Sewerage System

*Delete all sub clauses /item.*
13. **Storm water treatment unit**

*Add the following.*

Supply, install, test and commission Storm water treatment unit with total capacity of 21 m³/hr used for the treatment of the collected storm water to be used in the irrigation system, including but not limited to connection with tie-in points, filters, Micron filters, UV lamp unit, backwash pump, backwash tank, pumps, valves, gate valves if needed, overflow, Electrical works........etc, as per storm water treatment plant supplier design, client requirements/or engineers' requirements, in accordance with QCS 2014.
SECTION 12

EARTHWORKS
2. EXCAVATION

2.2 EXCAVATION FOR STRUCTURES

*Add new clause 2.2.2.5 as follows:*

**2.2.2.5 Dewatering**

In addition to the preceding clauses, the contractor is required to carry out an extensive study to determine the best/suitable method of discharging the ground water to the nearest sewage point or using water tanker or other means as may become necessary. The use of the water tankers as a means of discharge shall be taken as a matter of urgency in a situation where the discharge to the nearest sewage point becomes inaccessible due to any foreseen or unforeseen circumstances such as overflowing.

*Add new item 2.2.9 as follows:*

**2.2.9 Cavity Remediation**

1. The Contractor shall perform probing for cavity detection beneath shallow foundations, whenever existence of cavities within foundation bedrock is suspected.

2. Upon the Engineer’s request, the Contractor shall submit to the Engineer for his approval a detailed Method statement including detailed procedures for probing, cavity treatment, and full descriptions of the procedures, equipment, materials to be used, along with material test reports, and quality control.

3. Prior to commencement of works, the ground within the footprint of the probe zone shall be excavated to the foundation level.

4. After completion of treatment works at site, the Contractor shall submit complete reports of the probing and treatment that include actual locations of cavity/slump zone, summary of drilling records with rate of drilling, anomalies, full details of materials used, and pumping pressure.

5. Grout Mix: The Contractor shall submit his proposed grout mix designs (there can be more than one mix design if different grouting techniques are adopted) for the approval of the Engineer. Field trials shall also be carried out at locations approved by the Engineer to demonstrate that the Criteria of Acceptance is achieved and to confirm the grouting termination criteria.

   Chemicals like retarder have to be used if the injection time will be long and to...
prevent clogging of pipe during injection. However, any chemicals to be used shall be agreed by the Engineer.

The Contractor shall carry out trial mix at site to justify the workability and strength of the proposed grout mix.

The Contractor shall submit his proposed slump for the Engineer’s approval. In general the slump shall be tested on site for each batch of mix. 28-day compressive strength of grout mix shall not be less than of 10.0 Mpa (Cube Strength).

6 Execution:

(a) Cavities at the Foundation level:
   (i) If the Engineer determines that unsatisfactory soil is present, or cavities exposed at foundation level exist, the Contractor shall over excavate and clean cavities then replace with lean concrete fill with 28-day compressive strength of 20 MPa (Cube Strength), and as directed.

(b) Unexposed Cavities below shallow foundations:
   (i) Treatment Area and Depth: The limit of the area to be grouted and the exact location and required depth of the individual grout holes are not positively known but will be revealed by probing.
   (ii) Probing shall be conducted underneath each isolated footing with a minimum of one probe located at the center of the footing and underneath each raft foundation at a grid of 8mx8m. The depth of probing below foundation level shall be at least 2 times the foundation width or 10m, whichever is less.
   (iii) The diameter of the drill hole shall be large enough to allow grouting to be carried out immediately after reaching the required level without having to re-drill the hole after probing of cavities. The diameter of the drillhole shall be proposed by the Contractor and approved by the Engineer. If treatment of slump zone and cavity is not required, the drill hole shall be properly backfilled with cement-grout (W/C = 0.6) or low strength sand-cement grout to the existing ground level.
   (iv) Grout Injection Rates: Generally the Contractor shall adopt slower pumping rates in order to maximize grout intake and to ensure against occurrence of hydraulic fracturing. Subject to site trials demonstrating that the Criteria of Acceptance otherwise be achieved, the pumping or grout injection rate shall be less than 0.03 m3/min. or other approved rate. However, the Contractor should make sure that the grout would not set in the pumping pipe before completing the injection into slump zone or cavity.
(v) Grout treatment termination criteria shall be agreed upon with the Engineer after doing field trials for ground treatment.

(c) Criteria for acceptance of grout treatment:

(i) Acceptance Criteria for treated Zone: The grout treatment shall be considered successful if the results, obtained from additional probes carried out through the treated zone, confirm that the voids have been filled. The probes required to confirm that the acceptance criteria has been achieved shall be carried out 7 days after completion of grouting unless otherwise directed by the Engineer.

(ii) Grouting shall be repeated until compliance with the Criteria of Acceptance.

(iii) All boreholes and probes shall be grouted to the satisfaction of the Engineer immediately on completion.

7 Surface monitoring:

The Contractor shall undertake continuous surface monitoring for settlement or heave over the designated treatment area and beyond over the period of drilling and treatment.
3. FILLING

3.2 EARTHWORKS MATERIALS

*Add new item 3.2.5 as follows:*

3.2.5 Engineered Fill

The engineered fill from existing ground to foundation level shall be naturally or artificially graded mixture of natural or crushed gravel, crushed stone and natural or crushed sand, materials must comply with the following requirements:

(a) The material passing the 0.075 mm sieve shall not exceed 20%
(b) The liquid limit shall not exceed 35% and the plasticity index shall not exceed 10%
(c) The soaked CBR value shall not be less than 15%.
(d) The organic matter content shall not exceed 2%.
(e) Water soluble salts shall not exceed 5% by weight of dry soil.
(f) Particle size shall not exceed 75 mm.

3.5 COMPACTING IMPORTED OR SELECTED EXCAVATED FILL MATERIAL

3.5.1 General

*Add new item 12 as follows:*

12 The engineered fill shall be placed from existing ground to foundation level in loose layers not exceeding 150 mm and compacted to 95% of Modified Proctor (according to ASTM D 1557).
SECTION 13

MASSONRY
1. GENERAL

1.1 INTRODUCTION

1.1.1 Scope

Add the following new paragraph:

3 Where required, the work of reinforced concrete posts and beams for sub-dividing large areas of masonry walls shall be as indicated on structural Drawings and specified in Section 5 “Concrete”.

1.3 SAMPLES, TESTING AND SUBMITTALS

1.3.1 General Requirements

Amend paragraph no. 5 to read as follows:

5 Further samples shall be selected by the Engineer and tested by Contractor as specified in sub-clause 1.3.1 and 1.3.2.

Add the following new paragraphs:

7 Samples: For the following:
   
   (a) Full-size units for each different exposed masonry unit required, showing the full range of exposed colours, textures, and dimensions to be expected in the completed construction.
   
   (b) Accessories embedded in the masonry.
   
   (c) Reinforcing bars and accessories
   
   (d) Movement joint materials and sealants (one sample of each material and sealant).

8 Product data for all materials used in masonry works including, but not necessarily limited to, masonry units, mortar materials, fillers and joint materials, plasticizers, admixtures and joint sealants.

9 Submit List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

   (a) Submittal is for information only. Neither receipt of list nor approval of mock-up constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

10 Testing Agency, Testing and Inspection Agency, or similar words: An independent entity, acceptable to the Engineer, unless otherwise specified, to perform specific inspections or tests, at a specified location, and to report and interpret results of specified inspections or tests, for the purpose of verifying
11 Material Test Reports: From a qualified independent testing agency to indicate and interpret test results relative to compliance of the following proposed masonry materials for compliance with requirements indicated:

(a) Each type of masonry unit required.
   (i) Include size-variation data, verifying that actual range of sizes falls within specified tolerances.
   (ii) Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.

(b) Mortar complying with specified requirements.

(c) Grout mixes, Include description of type and proportions of grout ingredients

12 Fire-resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 or BS 476 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to Engineer.

13 Engineering Responsibility: of reinforced concrete masonry to include the following but not limited to:

(a) Determining the maximum unsupported height or length to thickness ratio, of all interior and exterior walls prior to beginning construction.

(b) Design of reinforced concrete masonry including concrete filled beams, post, pilasters, lintels and soffits. Accessories include, but are not limited to ties, horizontal and vertical reinforcement, anchors to the structure, and control joints.

(c) Design formwork, false work, shoring, shoring and back shoring required to properly execute work of this section, review of Drawings related to this Work, field review of construction of this Work and submission written Site Review Reports.

1.3.2 Sample Panels

Add the following new paragraph no. 4:

4 Sample panels include one mock-up for each type of walls or partitions. Build mock-ups using materials matching approved samples. Maintain mock-ups as standard for judgment completed masonry permanent works. Approved mock-ups will become part of permanent works.

Add the following new sub-clause numbered 1.3.3:

1.3.3 Field Quality Control

1 Testing Frequency: Tests and evaluations listed in this Article will be performed during construction for each 450 sq. m of wall area or portion thereof.

2 Mortar properties will be tested per BS 4551.
3  Grout will be sampled and tested for compressive strength per BS 1881.

4  Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to BS 6073.

### 1.4 PRODUCT HANDLING

#### 1.4.1 Storage of Materials

*Add the following new paragraphs:*

4  Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

5  Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

6  Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

### 1.5 WORKMANSHP

#### 1.5.1 General Requirements

*Add the following new paragraphs:*

6  Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.

   (a) When ambient temperature exceeds 35 deg C, or 32 deg C with a wind velocity greater than 13 km/h, do not spread mortar beds more than 1200 mm ahead of masonry. Set masonry units within one minute of spreading mortar.
2. MORTAR AND GROUT

2.1 GENERAL DESCRIPTION

2.1.2 References

*Delete in its entirety paragraph no. 1 and replace with the following:*

1. The following standards are referred to in this Part:

<table>
<thead>
<tr>
<th>Standard Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 882</td>
<td>Aggregates from natural sources for concrete</td>
</tr>
<tr>
<td>BS 1200</td>
<td>Building sands from natural sources</td>
</tr>
<tr>
<td>BS 4255-1</td>
<td>Rubber used in preformed gaskets for weather exclusion from buildings. Specification for non-cellular gaskets</td>
</tr>
<tr>
<td>BS 4551-1</td>
<td>Methods of testing mortars, screeds and plasters. Physical testing</td>
</tr>
<tr>
<td>BS 5628</td>
<td>Code of practice for use of masonry</td>
</tr>
<tr>
<td>BS EN 197-1</td>
<td>Cement. Composition, specifications and conformity criteria for common cements</td>
</tr>
<tr>
<td>BS EN 934-3</td>
<td>Admixtures for concrete, mortar and grout. Admixtures for masonry mortar. Definitions, requirements, conformity, marking and labelling</td>
</tr>
<tr>
<td>BS EN 998-2</td>
<td>Specification for mortar for masonry</td>
</tr>
<tr>
<td>BS EN 1015</td>
<td>Methods of test for mortar for masonry</td>
</tr>
<tr>
<td>BS EN 12350-2</td>
<td>Testing fresh concrete. Slump test</td>
</tr>
<tr>
<td>BS EN 12390-3</td>
<td>Testing hardened concrete. Compressive strength of test specimens</td>
</tr>
<tr>
<td>PD 6678</td>
<td>Guide to the specification of masonry mortar</td>
</tr>
</tbody>
</table>

2.2 MORTAR MATERIALS

2.2.1 Preparation Requirements

*Add the following at the end of paragraphs no. 5:*

5. “Plasticizers and admixtures shall be in liquid form. Use of dry admixtures in powder form shall not be acceptable.”

*Add the following new paragraphs:*

7. Mortar of internal and external masonry shall be Class M5 (Cement: Sand with Plasticizer) to give compressive strength not less than 5 MPa after 28 days and not exceed compressive strength of concrete masonry units. Testing shall be according to BS 4551-1.

8. Mortar shall be mechanically mixed in suitable movable drum mixers.

9. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a pre-
blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

10. **Job-Mixed Mortar:** Prohibited admixtures: calcium chloride, ethylene and any admixtures containing calcium chloride. Maximum working time is to be two hours a normal temperature, unless otherwise recommended by manufacture.

### 2.2.2 Cement

**Replace paragraphs no. 1 and 2 with the following new paragraphs:**

1. Cement for mortar and grout shall be ordinary Portland to BS EN 197-1 and relevant provisions of Section 5, Concrete.

2. Mortar for use in contact with the ground will be mixed using sulphate resistant cement and comply with the relevant provisions of Section 5, Concrete, unless recommended by Geo-Technical Report.

### 2.2.3 Aggregates

**Replace paragraph no. 1 with the following new paragraphs:**

1. Standard: BS EN 13139

2. Grading: 0/2 (FP or MP)
   
   (a) Fines: content where the proportion of sand in a mortar mix is specified as a range:
   
   (i) Lower proportion of sand: Use category 3 fines.
   
   (ii) Higher proportion of sand: Use category 2 fines.

### 2.2.5 Lime

**Replace paragraph no. 1 with the following new one:**

1. Do not use lime in mortar or grout admixtures. Use of plasticizers or admixtures that replace effect of lime shall be acceptable.

### 2.5 Grout

#### 2.5.1 General Requirements

**Delete in its entirety paragraphs 1, 2, 4 and 5 and replace with the following:**

1. Grout for Concrete Masonry: Comply with the following requirements:

   (a) Binding Material: Ordinary Portland cement. Do not use lime. Minimum cement content shall be 300 kg/m3.

   (b) Aggregates: As specified in Sub-Clause 2.2.3 of this section

   (c) Slump: 200-280 mm to BS 1881-102.

   (d) Admixture: Approved liquid types.

   (e) Minimum Compressive Strength: Minimum 15 MPa at 28 days when tested to BS EN 12390-3.
2 Concrete grout shall be used or filling hollow cells in bond beams, window and
door jambs and other locations as specified shall be mechanically mixed in drum
mixers in volumetric proportions with only enough water added to the mixture to
produce a mixture which is flowable, but which will not show an excess of water
when placed.

4 The Contractor shall submit laboratory design mix of concrete grout to obtain
performance specified in paragraph 1 of this paragraph.
3. **ACCESSORIES**

3.2 **ANCHOR AND TIE SYSTEMS**

*Add the following new clauses:*

3.2.2 **Adjustable Anchors for Connecting to Concrete**

1. Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 1.6-mm-thick, steel sheet, galvanized after fabrication.

3.2.3 **Miscellaneous Anchors**

1. Post installed Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

   (a) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).

3.3 **CONTROL JOINTS**

3.3.1 **Movement Joints**

*Replace paragraph no. 1 with the following paragraph:*

1. Movement joints shall be 12 mm wide formed using special block units and pre-molded rubber joint sections according to the following criteria:

   (a) Where indicated on Drawings.

   (b) Each 8 meters for continuous runs of masonry walling with 3 meters or less in height.

   (c) Each 6 meters for continuous runs of masonry walling more than 3 meters in height.

*Add the following new paragraph:*


3.5 **LINTELS**

3.5.1 **Precast or Cast In-Situ Lintels**

*Add the following new paragraph:*

4. Unless otherwise indicated on Drawings, lintels for opening 600 mm and less shall be prefabricated factory coated mild steel lintels suitable for the span.
Add the following new clauses:

3.6 JOINT FILLERS AT TOP OF BLOCKWORK

1 Fillers for joints between top of masonry walls or partitions and overlaying concrete beams or slabs for non-fire-rated assemblies shall be pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35%; of width and thickness indicated; formulated from neoprene.

2 Fillers at head of fire-rated masonry walls and partitions shall be as specified in this Section in joint between top of partition and underside of structure. Fill joints at both faces with fire rated elastomeric silicone sealants to comply with a UL-listed joint system at head of wall. Comply with requirements of Section 24 Part “Joint Sealants and Caulking”.

3.7 MISCELLANEOUS MASONRY ACCESSORIES

3.7.1 Preformed Control-Joint Gaskets

1 Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

3.7.2 Bond-Breaker Strips

1 Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

3.7.3 Weep/Vent Products

1 Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 9-mm OD by 100 long.

3.7.4 Cavity Wall Insulation

1 Board Insulation: A rigid thermoset insulation board faces on both sides with a low emissivity composite face foil, manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP); under a management system certified to EN ISO 9001, EN ISO 14001.

   (a) Thermal Conductivity (Aged Value over 25 Years): 0.020 W/mK.

   (b) Fire Performance: Maximum flame-spread of 25 and smoke-developed Indexes of 50, per ASTM E 84.

   (c) Insulation materials shall be inert, durable, rot-proof, resists attack from mould and microbial growth and does not provide any food value to vermin.

   (d) Thickness: minimum, 50 mm thick to achieve maximum assembly U-Value (aged Value Over 25 years) as indicated in Section 07.
4. UNIT MASONRY

4.1 GENERAL

4.1.1 Scope

Add the following new paragraph:

4 "Type of masonry units used in this project shall be non-load bearing concrete masonry as specified in clause 4.4 of Section 13 of the QCS and these amendments. Compressive strength mentioned shall be on net area of block."

4.4 CONCRETE MASONRY UNITS

4.4.1 Concrete Blocks

Add the following at end of paragraph no. 1:

(a) "Blocks, cellular (hollow) or solid shall be normal weight, of average intensity of 2000 kg/m³ for non-load bearing blocks. Minimum cement content shall be 350 kg/m³. Do not add lime to the mix."

Add the following new paragraph:

16 Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per BS 476 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

4.4.3 Blocks Dimensions

Add the following new paragraph no. 3:

3 Other types of concrete masonry shall be as follows:

(a) Use solid blocks for walls, partitions or wythes to be finished with mechanically attached dimension stone cladding.

(b) Use solid blocks and units for 100 mm thick partitions.

(c) As indicated on Drawings.
5 MASONRY LAYING

5.1 INTRODUCTION

5.1.1 Scope

Delete in its entirety paragraph no. 1 and replace with the following:

1 The following parts of Section 13 relate to this Part:
   
   Part 1  General
   Part 2  Mortar and Grout
   Part 3  Accessories
   Part 4  Unit Masonry

2 The following QCS 2010 Specifications Sections relate to this Part:
   
   Section 05  Concrete
   Section 17  Metalwork

5.1.2 References

Add the following References:

- BS 5628-3 Code of practice for use of masonry. Materials and components, design and workmanship.
- ASTM D 1751 Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types).

5.2 WORKMANSHIP

Add the following new paragraph no. 2:

2 General: Construct concrete masonry units according to requirements of BS 5628-3.

5.3 BLOCKWORK

5.3.1 Setting Out of Blockwork

Amend sub-paragraph (c) of clause 5.3.1 to read as follows:

(c) Compliance with tolerances stated in paragraph 3 of this clause.

Delete in its entirety Table 5.1 and replace with the following paragraph:

3 Set out the work carefully to ensure satisfactory junctions and built-in elements. Keep courses level, true to lines and evenly spaced. For exposed masonry, use gauge rods. Accurately plumb all faces, angles, and features within the following maximum tolerances:
Position in plan of any point in relation to the nearest building grid line at the same level            +/-3

Level of bed joints:
Up to 5 m long                                           +/-10
5 to 10 m long                                            +/-15
Over 10 m long                                            +/-25

Straightness in any 5 m length                           +/-10

Vertically:
In any 3 m height                                       +/-6
In overall height of building exceeding 6 m             +/-10

Thickness:
Overall thickness of walls                              +/-10

5.3.2 Wetting Blockwork Units

Delete its entirely content and replace with the following paragraph:

1. Avoidance of suction in concrete blocks: All bocks should be moisture cured at the factory, use water retaining mortar mixture.

5.3.3 Laying of Blockwork

Replace paragraph no. 1 with the following:

1. Block walls are to be built from concrete masonry units as specified in running bond with each course interlocked at corner or intersection (toothed masonry).

Add the following new paragraphs:

13. Build chases and recesses as shown and as required for the work of other trades.

14. Cut Concrete masonry units with motor-driven dry-cutting saws designed to cut masonry with clean, sharp and unchipped edges. Cut units as required to provide pattern shown and to fit adjoining work neatly. Use full units without cutting and special pieces as per paragraph 5 of this clause to the maximum possible extent.

15. Do not apply concentrated loads for at least 3 days after building masonry walls or partitions.

16. Internal faces of masonry shafts for ventilation and other requirements shall cleaned during progress of the work and maintained free of projections.

5.5 REINFORCEMENT

5.5.1 General Requirements

Replace paragraph no. 1 with the following:

1. Uncoated Steel Reinforcing Bars: ASTM A 615 M Grade 420.
3 Masonry Joint Reinforcement:
   (a) Interior Walls: Hot-dip galvanized, carbon steel.
   (b) Exterior Walls: Hot-dip galvanized, carbon steel.
   (c) Wire Size for Side Rods: 4.8-mm diameter.
   (d) Wire Size for Cross Rods: 4.8-mm diameter.
   (e) Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 407 mm o.c.
   (f) Provide in lengths of not less than 3 m, with prefabricated corner and tee units.


5 Horizontal Reinforcement:
   (a) Provide horizontal reinforcement at each second course of blockwork and embed in mortar joints.
      (i) Space reinforcement not more than 400 mm o.c.
      (ii) Space reinforcement not more than 200 mm o.c. in foundation walls and parapet walls.
   (b) Provide reinforcement in the first blockwork joint above and below wall openings and extending 300 mm beyond openings. Reinforcement above and below opening shall be in addition to continuous reinforcement.
   (c) Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.
   (d) Interrupt joint reinforcement at control joints, unless otherwise indicated.

5.10 JOINTS BETWEEN PARTITIONS AND FLOOR SOFFITS

5.10.1 General requirements

Add the following new paragraph:

4 At fire-rated walls or partitions, install fire stopping joint filler as specified in this Section in joint between top of partition and underside of structure. Fill joints at both faces with fire rated elastomeric silicone sealants to comply with a UL-listed joint system at head of wall. Comply with requirements of Section 24 Part 10 “Joint Sealants and Caulking”.

5.11 FILLING HOLLOW BLOCK WALLS

5.11.1 General requirements

Amend first sentence of paragraph 1 to read as follows:

1 In the following situations, the cavities of hollow block walls are to be filled with
grout as specified in this section.

5.12 CAVITY WALLS

5.12.1 General requirements

*Add the following new clause:*

5 Coat cavity face of outer wythe with cold-applied bitumen-based damp proofing material to comply with ASTM D 1227, Type II, Class 1. Apply in full conformance with manufacturer’s printed instructions.

6 Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

7 Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 300 mm o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

(a) Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

*Add the following new clauses:*

5.16 CONTROL JOINTS

1 General: Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

2 Form control joints in concrete masonry as follows:

(a) Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake joints in exposed faces.

(b) Install preformed control-joint gaskets designed to fit standard sash block.

(c) Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake joint.

(d) Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete.

5.17 REPAIRING

1 Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

2 In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
5.18 MASONRY WASTE DISPOSAL

1. Excess masonry materials are Contractor's property. At completion of masonry works, remove from Project site.
SECTION 14

ROOFING
1 GENERAL

1.1 INTRODUCTION

1.1.2 References

(a) The Materials shall meet the Specified Standards for the Works, suitable to the Local Climatic Conditions, and in accordance with the requirements of the Building Codes of Practice.

(i) Acceptable standards of reference are as follows
   1) ASTM C518 : 2004
   (ii) Thermal Transmission Properties by Heat Flow
        1) ASTM D 1622 : 03
   (iii) Apparent Density of Rigid Cellular Plastic
         1) ASTM D -1621: 00
   (iv) Compressive Strength of rigid Cellular Plastics
        1) ASTM 0 2126:04
   (v) Thermal & Humid Aging (Dimensional Stability) at Specific Conditions
      1) ASTM C 209: 1998
   (vi) Water Absorption Test (Thermal Insulation)

1.1.4 Quality Assurance

1 General

(a) Roofing Contractor shall be following proper quality control procedures, with emphasis on quality management systems assuring quality service

(i) Identification: All material shall be identified by manufacturer's stickers.

(ii) Handling: All raw materials shall be transported as per instructions from manufacturer's manual.

(iii) Storage: All raw materials shall be kept in shaded area with dear identification until it is used.

(iv) During application the roof shall be protected by polyethylene sheet to avoid the risk of over spray and spillages.

(v) Delivery and handing Over: After completion of all roofing works, the finished roof to be handed over to the client officially using a completion report.

(vi) Contractor shall submit its works program and its On-Site to Quality Control Plan.

2 Protection And Safety On Site:

(a) The Contractor shall abide by all means to national and international labour and health regulations. Safety precautions on site shall incorporate, but are not limited to:
(i) All ladders and temporary stairs to be well secured at top and bottom.
(ii) Sufficient number of fire extinguishers to be made available during Works
(iii) Required polyethylene sheet or tarpaulin to restrict spraying on adjacent
(iv) structures or equipment.
(v) Workers to wear safety gloves and protection clothes.

3 Water Testing:
(a) Flood test 48 hours minimum after completion of waterproofing works.
(b) Restrict water run-off from waterproofed area by plugging drains and creating dams or dikes. Flood restricted area to depth of about 25 to 30 mm and maintain at this depth for 48 hours.
(c) Repair any leaks that develop and retest.
(d) At completion of flood test, drain plugs shall be removed.

4 Guarantee:
(a) 25 Years guarantee shall be provided by the Manufacturer jointly with certified applicator to the benefit of the Client for materials and workmanship of roof waterproofing. This warranty shall clearly include the following:
(b) All materials in the waterproofing system shall be free from manufacturing defects and comply with manufacturer's published technical specifications.
(c) All workmanship in waterproofing systems shall be free from any defects and comply with all respect to the manufacturer's technical instructions and control.
(d) This warranty becomes operative from the date of installation and shall be valid for a period of 25 calendar years.
(e) Within this warranty the contractor is liable for the cost of repair of defective materials and installation and replacement materials of the failed system.

1.1.5 Submittals

1 Submittals:
(a) Product Data sheets
(b) Specification
(c) Shop Drawings.
(d) Material Samples
   (i) Accepted samples will be retained to serve as a basis for checking at the time of delivery of materials at site.
   (ii) The manufacturer shall furnish, when requested, proof of origin and quality of the materials that will be used or where it has been applied.
   (iii) Only materials specified or approved by the Engineer shall be permitted to be used.
(iv) The Engineer will stipulate acceptance tests and their mode of operation to be carried out on materials supplied by the contractor.

2 Water Proofing Contractor Certification:

(a) Submit manufacturer’s approval of applicator.

(b) Submit complete details about the sub-contractor’s company: Company profile, list of specialized staff with their respective qualifications and experience in Qatar or in Gulf, references (minimum 5 years), evidence of their ability to handle projects of a similar volume, specific experience in Qatar or in the Gulf and list of equipment.

3 Manufacturer Approval:

(a) It is preferred that the water proofing material manufacturer shall be certified within the frame of ISO 9000 series standards: ISO Certificate should be available for Engineer checking at time of submission.

(b) The manufacturer’s in-house quality control shall be periodically audited by an independent technical control office for compliance with the QCS manual and standard recommendations.

(c) The Contractor shall submit along with his tender bid, the evidence to demonstrate his arrangements with the material manufacturer and the approved applicator, the arrangements to cover defects in material and workmanship in form of and other guarantees. The guarantees under reference shall be for a minimum period of Twenty Five (25) years.

(d) Guarantees to be provided shall be valid within the State of Qatar

4 Storage Of Materials:

(a) All materials shall be stored in dry area, out of direct sunlight and according to manufacturer’s instructions.

(b) It is not permitted to store material on the building in such concentrations as to impose excessive stress and strain on deck or structural members.

(c) In the event that any materials for use in this section deteriorate and become unusable due to inadequate and poor storage they shall be removed from site as instructed by the Engineer.
2 MEMBRANE ROOFING

2.1 GENERAL

1 Unless otherwise mentioned in the Drawings the Following Procedure should be followed:

2 The water proofing works shall carry a minimum of 25 (Twenty Five) years manufacturer's guarantee to cover performance of the materials used and the workmanship.

2.8 MATERIALS

2.8.1 Description

2 Spray Applied Polyurethane Foam
   Grade: Spray
   Thickness: 110 mm
   Density: 55 to 60 Kg/ m'
   Compressive strength: 3.5-4.00 kg / em'
   Tensile strength: 3.6-3.9 kg / em'
   Thermal Conductivity: 0.023W/(mk) (aged value)
   Closed cells: 98%
   Standards: BS 5241- part 1

3 Liquid Elastomeric Coating (Uv Coating)
   Grade: Spray I Brush
   Thickness: 500 - 700 microns
   Base: Water based (green)
   Solid Content: 60%
   Elongation: 1200%
   Crack bridging ability: 2mm

4 Protection Laver, Geo-Textile
   Grade: Filter membrane
   Mass: 100 gm I m2
   Thickness: 1.50 mm
Elongation: 50%

Fabric Colour: White

5 Expansion Joint Filler Board

Grade: Joint filler board

Thickness: 6-12 mm

Density: 50-220 Kg / m'

6 Screed Concrete (Recommended Fall 1: 100)

Grade: Pouring

Cement Type: OPC

Cement Content: 300 Kg/ m3

Strength: 20 N / m2

Minimum Thickness: 50mm

7 Polyurethane Sealant

Grade: Pouring

Solid Content: 100%

Temperature Resistance: (-20 0 C to 1200 C)

MAF: +/-25%

8 Solar Reflective Coating

Grade: Brush / Spray

Thickness: 500 - 700 microns

Solid Content: 63%

Colour: White

Solar Reflectivity: 86%

2.8.2 Installation

7 Upon casting and complete curing of roof slab, Certified Applicator's Engineer shall visit the site to inspect the roof and accept the roof for waterproofing and heat insulation works. A preliminary site inspection shall be carried out and any further preparation work if required shall be brought to the attention of the main contractor. Prior to commencement of roof waterproofing works, main contractor shall make sure following conditions are met:
8 All joints existing between roof slabs other than expansion joints provided shall be filled with mortar.

9 All electrical conduit and other service entries to slab shall be closed with mortar.

10 Sides of electrical conduits and service entries shall be sealed with mortar.

11 Rain water pipes shall be in place at specified height as per slope.

12 Vertical parapet wall shall be plastered leaving 350 mm height from the slab level.

13 Roof door threshold shall be in place.

14 AC or water pipe sleeves shall be in place at a minimum height of 350mm.

15 All other works on the roof shall be completed prior to the commencement of waterproofing works.

16 On acceptance of roof from the main contractor, application crew of the approved applicator shall visit the site to commence cleaning operations using compressed air to free the entire substrate from dust and any other loosely lying particles.

17 On completion of cleaning works, other preparatory works shall be undertaken like covering of parapet wall and other utilities fixes on the roof to avoid the risk of over spray.

18 Upon completion of preparatory works "Roof Waterproofing" system application shall commence where polyurethane foam is sprayed onto the roof slab incorporating VMG grid to facilitate EFVM testing as and when required. The spray applied system forms an impermeable water proofing cum insulation layer with high thermal resistance, closing all pores and cracks that exists in the roof slab.

19 On completion of polyurethane foam application, "liquid Elastomeric Coating" water proofing coating shall be applied over entire foam to form a uniform coating.

20 Once elastomeric coating is completely cured for 48 hours, applicators' Engineer shall visit the site to inspect the works completed and carry out a "flood water test for 48 hours". On successful completion of flood test a report shall be prepared and maintained for records.

21 On successful completion of flood test, water shall be removed and "Geomtextile Membrane" shall be laid as a protection layer over the entire roof area prior to commencement of screeding works.

22 Applicator's Engineer shall make level markings for screeding at site and screeding crew of the manufacturer shall commence the paneling works using "expansion joint filler board" and pre·mixed cementatious adhesive mortar to attain the desired slope levels as indicated in the approved drawing.

23 Once screed is completely cured, all construction joints shall be opened and treated using heavy duty "polyurethane sealant" and backing rod for accommodating movement of the concrete during expansion and contraction.
24 When sealant applied is completely cured, "Solar reflective elastomeric coating" shall be applied (excluding where the sealant is applied) over entire screed including upstands to form a uniform coating.

25 All vertical up stands will be protected with 150mm girth extruded.

26 Once the final coat is completely cured for 48 hours, Manufacturer's Engineer shall visit the site for final inspection and a life time guarantee of 25 years shall be issued.
SECTION 15

THERMAL INSULATION OF BUILDINGS
1. GENERAL

1.1 INTRODUCTION

1.1.1 Scope

**Add the following new paragraphs:**

3. This section covers the work of building insulation including concealed and exposed insulation to be installed in locations indicated on Drawings and approved shop drawings.

4. Included also in this section, Perimeter Fire-Containment safing systems for use between curtain walls and fire-resistant-rated floor assemblies.

5. Perimeter fire-containment systems.

6. Vapour retarders.

7. The work of roofing thermal insulation is not part of the work of this Section and covered in Section 14 "Roofing”

1.2 MATERIALS

1.2.2 Submittals

**Add the following new paragraphs:**

4. Submittals are also to include: product test reports based on evaluation of comprehensive tests performed by a qualified testing agency acceptable to the Engineer, for insulation products.

5. Document Conflict and Precedence:

   (a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

   (b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

1.2.3 Storage

**Add the following new sub-Clausess:**

2. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer’s written instructions for handling, storing, and protecting during installation.

3. Protect plastic insulation as follows:

   (a) Do not expose to sunlight, except to extent necessary for period of
installation and concealment.

(b) Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.

4 Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

Addon the following new Clause:

1.2.4 Quality Assurance

1 Source Limitations: Obtain each type of building insulation through one source.

2 Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction and Engineer, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

3 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.
2. BUILDING INSULATION

2.1 GENERAL

2.1.1 Scope

2 Related Sections also include 25 “Glass and Glazing”.

2.4 INSULATION MATERIAL TYPES

Add the following new Clauses:

2.4.10 Perimeter Fire-Containment Systems

1 Board Insulation: A rigid thermoset insulation board faces on both sides with a low emissivity composite face foil, manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP); under a management system certified to EN ISO 9001, EN ISO 14001.

(a) Thermal Conductivity (Aged Value over 25 Years): 0.020 W/mK.

(b) Fire Spread: Rated Class 0 to BS 467: Parts 6 and 7; non-combustible to Part 4.

(c) Insulation materials shall be inert, durable, rot-proof, resists attack from mould and microbial growth and does not provide any food value to vermin.

(d) Thickness: Minimum thickness to be as indicated below and on Drawings to achieve maximum assembly U-Value (aged Value Over 25 years) as indicated in Section 07:

(i) Cavity concrete block walls: minimum, 50mm thick.

(ii) Spandrel double glass types: minimum, 50mm thick.

(iii) Spandrel single glass types: minimum, 75mm thick.

(iv) Aluminum composite / metal Cladding: minimum, 75mm thick.

(v) Stone cladding: minimum, 75mm thick.

(vi) GRP/GRC cladding: minimum, 75mm thick.

(vii) Any other Cladding systems: minimum, 75mm.

2.4.11 Vapour Barrier

1 Polyethylene Vapour Barrier: Polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.

2 Vapour-Retarder Tape: Pressure-sensitive tape of type recommended by vapour retarder manufacturer for sealing joints and penetrations in vapour retarder.
2.5 INSTALLATION

2.5.8 Execution and Workmanship

Add the following new paragraphs:

1 Examination: Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

2 Preparation: Clean substrates of substances harmful to insulations and vapour retarders, including removing projections capable of puncturing vapour retarders or of interfering with insulation attachment.

3 Installation, General:

(a) Comply with insulation manufacturer's written instructions applicable to products and application indicated.

(b) Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.

(c) Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

(d) Water-Piping Coordination: If water piping is located on inside of insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

(e) Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

2.5.9 Perimeter Insulation

Add the following new paragraphs:

1 On vertical surfaces, set units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.

(a) If not indicated, extend insulation a minimum of 600 mm below exterior grade line.

2 Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection board. Set in adhesive according to insulation manufacturer's written instructions.

Add the following new clauses:

2.5.10 Installation of General Building Insulation

1 Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
(a) Retain insulation in place by metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.

(b) Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

2.5.11 Installation of Perimeter Fire-Containment Systems

1 Install perimeter fire-containment systems to fill gap between edge of concrete floor slab and back of spandrel panels of exterior curtain-wall systems to comply with fire-containment system manufacturer's written instructions to produce installations with ratings matching those established during fire-test-response testing.

2.5.12 Protection

1 Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
SECTION 16

STRUCTURAL STEELWORKS
1. GENERAL

1.1.2 References

Delete all standards under sub-clause 1 and replace with the following:


2. AISC’s “Specification for Structural Steel Building – Allowable Stress Design” including “Commentary” and Supplements thereto as issued.

3. AISC’s “Specification for Allowable Stress Design of Single-Angle Members”.

4. AISC’s “Seismic Provisions for Structural Steel Buildings”.

5. ASTM A6 (ASTM A6M) “Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use”.


8. AISC’s “Specification for Architecturally Exposed Structural Steel”.

1.1.3 System Description

Delete sub-clauses (a) and (b) and replace with the following:


(b) AISC’s “Specification for Structural Steel Building – Allowable Stress Design” including “Commentary” and Supplements thereto as issued.

(c) AISC’s “Specification for Allowable Stress Design of Single-Angle Members”.

(d) AISC’s “Seismic Provisions for Structural Steel Buildings”.

(e) ASTM A6 (ASTM A6M) “Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use”.

(f) Research Council on Structural Connections' (RCSC) “Specification for Structural Joints Using ASTM A325 or A490 Bolts.”

(g) American Welding Society (AWS) D1.1 – 2008 “Structural Welding Code – Steel - with its associated errata 2009”.

(h) AISC’s “Specification for Architecturally Exposed Structural Steel”.
1.2.4 Design Drawings

Amend sub-clause 1 to read as follows:

 Fully dimensioned drawings prepared by the Engineer showing all members with their size.

1.2.5 Erection Drawings

Amend Clause title to read as follows:

1.2.5 Lifting-up and Erection Drawings

Delete the words “…when necessary…” from the first line of sub-clause 1.
Insert the words “…lifting-up and…” after “…given in the Contractor’s…” in sub-clause 1.

1.2.10 Shop Drawings

Amend the sub-clause 1 to read as follows:

 Drawings, prepared by the Contractor, showing plans, cross sections and elevations, main dimensions and the erection marks of all steel the components. These drawings should show all the steel details of all the main and secondary beams, columns and all other steel elements in addition to all details of connections (welded and bolted) for all the steel elements.

1.2.11 Ordinary Bolts

Add the following to sub-clause 1:

 It is used only where specified in the drawings. Otherwise, high strength bolts are used for all other connections.

1.2.16 Full Penetration Weld

Add the following to sub-clause 1:

 The preparation of surfaces and all other welding procedures should be in accordance with the AWS: Structural Welding Code, American Welding Society, AWS D1.1 – 2008.

1.2.17 Partial Penetration Weld

Add the following to sub-clause 1:

 The preparation of surfaces and all other welding procedures should be in accordance with the AWS: Structural Welding Code, American Welding Society, AWS D1.1 – 2008.

1.2.18 Full Strength Weld

Delete clause entirely.
2. MATERIALS

2.1.2 References

Delete all standards under sub-clause 1 and replace with the following:

ASTM A572M: Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A913: Standard Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST)
ASTM A500: Standard Specification for Cold formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated, welded and seamless
ASTM A618: Standard Specification for Hot-Formed Welded and Seamless High Strength Low Alloy Structural Tubing.
ASTM A653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM 924M: Standard Specification for General Requirements for Steel Sheet, Metallic-coated by the Hot-Dip Process
ASTM A108: Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A370: Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A449: Standard Specification for Quenched and Tempered Steel Bolts and Studs
ASTM A490M: Standard Specification for High-Strength Steel Bolts, Classes 10.9 ad 10.9.3, for Structural Steel Joints (Metric)
ASTM A 325M: Standard Specification for High-Strength Steel Bolts, Classe 8.8, for Structural Steel Joints (Metric).
ASTM 307: Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
ASTM F959: Standard Specification for Compressible-Washer-Type Direct Tension Indicator for Use
2.1.3 Material Qualities

In sub-clause 1, delete the clause “shown in Table 2.1” and replace with “as shown hereafter”.

Delete sub-clause 2 completely.

2.1.4 Material Testing

Delete sub-clause 1 and replace with the following:

Submit producer's or manufacturer's specifications and installation instructions. Include mill test reports in accordance with ASTM A6M, laboratory test reports and other data to show compliance with specifications (including specified standards) for the following products:

1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
3. Direct-tension indicators.
4. Shear stud connectors.
5. Shop primers.
7. Welding electrodes

2.1.5 Test Certificates

Add the following new sub-clause 2:

Submit copies of reports of tests conducted on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results. State compliance or non-compliance with specifications.
2.1.6 Dimensions and Tolerances

In sub-clause 1, delete “shown in Table 2.1” and replace with “as as the AISC, the AWS and as per section 7 and 9”.

Delete Table 2.1 Material and Dimension Standards.

Delete the sub-clause Notes completely.

2.2.1 General

Delete sub-clauses 1, 2 and 3 and replace with the following sub-clause 1:

For fabrication of work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.

2.4 WELDING CONSUMABLES

Delete Clauses 2.4.1 and 2.4.2 and replace with the following:

Welding Materials: Conform to AWS D1-1 Code and AWS Filler Metal Specifications. Select materials, which are suitable for use with types of steel to be joined. Unless otherwise indicated, connections are designed for:


2. Bare Electrodes and Granular Flux used in the submerged-arc process are to conform to F7 X-EXXX AWS flux classifications of the Specification for Base Mild Steel Electrodes and Fluxes for Submerged Arc Welding, AWS A5.17, or A5.23 or the of AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".

2.5.1 Ordinary Bolt Assemblies

Delete sub-clauses 1, 2 and 3 and replace with the following sub-clause 1:

Nonhigh-Strength Bolts, Nuts, and Washers: ASTM A325, Grade A, regular low-carbon hexagonal head steel bolts and nuts and washers, to be used only when specified.

2.5.2 High Strength Friction Grip (Hsfg) Bolt Assemblies

Amend Clause Title to read as follows:

2.5.2 High Strength Bolt Assemblies
Delete sub-clauses 1 and 2 and replace with the following sub-clause 1:

High-Strength Bolts, Nuts, and Washers: ASTM A490M, Type 1, or DIN 6914 grade 10.9 heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers, uncoated. Typically used unless otherwise noted.

1. Direct-Tension Indicators: ASTM F959, Type 490, uncoated.

2.5.3 Foundation Bolts

Delete sub-clause 1 and replace with the following:

1. Unheaded Rods: ASTM F1554 - 36 with minimum yield strength of [36 KSI], to be used only when specified.

2.5.4 Cup and Countersunk Bolts

Delete clause entirely.

2.5.5 Washers

Delete clause entirely.

2.5.6 Lock Nuts

Delete clause entirely.

2.5.7 Fastener Coatings

Amend Clause number to be: 2.5.4

2.6 SHEAR STUDS

Delete sub-clause 2.6.1 GENERAL and replace with the following Clause:

Headed Stud-Type Shear Connectors: to AWS D1.1, type B, minimum yield strength of 345 N/mm² [50000 PSI] at 0.2% offset, made from steel to ASTM A108, with mechanical properties to ASTM A370, and applied in accordance with Recommended Practices for Stud Welding.

2.7 PROTECTIVE TREATMENT MATERIALS

Delete Clause entirely (title and sub-clauses 2.7.1 to 2.7.5) and replace with the following new Clauses:

2.7 STRUCTURAL STEEL SHAPES, PLATES, AND BARS

1. Structural steel shapes, plates and bars as follows:

   (a) Carbon Steel: ASTM A36M having a minimum yield stress of 240 N/mm² or equal, typically used unless otherwise noted.
2.8 COLD FORMED STRUCTURAL STEEL TUBING

Structural steel square and rectangular tubes are to conform to ASTM A500 with the following characteristics: Minimum yield Stress, 315 N/mm².

2.9 COLD ROLLED STEEL Z AND C SECTIONS

Cold rolled steel Z and C sections to be ASTM A653M grade HSLAS, type A, Grade 50 (340) and ASTM A924/A924M, having a minimum yield stress 345 Mpa, or equal, and shall be galvanized to achieve the specified life to first maintenance.

2.10 STAINLESS STEEL PLATES

Stainless steel plates for Teflon bearings to conform to AISI TP 316 or equal.

2.11 POLYTETRA FLUOROETHYLENE (PTFE) SHEETS

Polytetra fluoroethylene (PTFE) sheets are to conform to ASTM D9894 and D9895.

2.12 STEEL CASTINGS

2.12.1 High Strength Steel Castings

High strength steel castings conform to ASTM A148M grade 795-655 or approved equal.

2.12.2 Carbon-Steel Castings


2.12.3 High Strength Steel Castings

ASTM A148M, Grade 550 – 345
ASTM A148M, Grade 795 – 655

2.13 NON-SHRINK RHEOPLASTIC EXPANSIVE CEMENT GROUT

Non-shrink Rheoplastic Expansive Cement Grout: Free flowing, non-shrink, non-ferrous rheoplastic, oil resistant, water resistant, complying with CE-CRD-C621, having minimum compressive strength of 60 MPa.
3. **DRAWINGS**

3.1.2 **References**

_Delete all standards under sub-clause 1 and replace with the following:_


3.1.3 **General Requirements**

_Ampend sub-clause 1 by replacing “BS 1192 Parts 1 and 2” with “AISC, AISI and AWS D1.1”._

_Ampend sub-clause 2 by replacing “BS 499 Part 2” with “AWS D1.1”._

3.2.1 **Marking System**

_Ampend sub-clause 1 to read as follows:_

General arrangement Drawings shall be made by the Contractor and every component which is to be individually assembled or erected shall be allocated an erection mark.

3.3.1 **General Requirements**

_Insert the following to sub-clause 1 after “Foundation Plan Drawings shall”:_

“… be prepared by the contractor to…”

3.4.1 **Fabrication Shop Drawings**

_Ampend sub-clause 1 to read as follows:_

1. Fabrication Drawings shall be prepared by the Contractor to show all necessary details and dimensions of all steel elements, connections and fittings to enable fabrication of components to proceed.

2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.

5. Include Shop Drawings signed and sealed by a qualified professional engineer.
responsible for their preparation.


7. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS A2.1 and A2.4 symbols, and show size, length, and type of each weld.

3.4.2 Attachments to Facilitate Erection

Add the following to sub-clause 1:

1. Each of these holes and fittings shall be subject to the Engineer’s approval.

3.4.5 Hole Sizes

Amend sub-clause (a) to read as follows:

(a) for ordinary bolts and high strength bolts:

(i) The allowable clearances for bolt holes should be restricted to the requirements of the AISC for all bolt dimensions.

Amend sub-clause (c) (i) to read as follows:

(i) in accordance with the AISC

3.4.6 Holding Down Bolt Covers

Delete “3 mm” and replace with “2 mm”. In general, the tolerance for bolt holes should be restricted to the limits as per the AISC.

3.4.9 Drilling Note

Delete sub-clause 1 and substitute with the following:

The Fabrication Drawings prepared by the Contractor shall indicate those locations where holes shall be drilled (see also Clause 4.7.3 of this Section).

3.4.10 HSFG Faying Surfaces

Amend Clause title to read as follows:

3.4.10 High Strength Bolts Faying Surfaces

Delete sub-clause 1 entirely and replace with the following:

When considering the use in the design of high strength bolted connections the treatment of faying surfaces shall be as follow:

(a) unless the Engineer advises otherwise, treatment of surfaces shall be in accordance with RCSC’s specifications for structural joints using ASTM A490M bolts as per the AISC.
3.5 ERECTION DRAWINGS

3.5 LIFTING-UP AND ERECTION DRAWINGS

3.5.1 Erection Method Statement

Amend Clause title to read as follows:

3.5.1 Lifting-Up and Erection Method Statement

Amend sub-clause 1 by inserting “lifting-up and” before the word “erection”.

3.5.2 Temporary Steelwork

Amend sub-clause 1 by inserting “lifting-up and” before the word “erection”.

3.6.2 Meaning of Acceptance

Delete from the end of sub-clause 1 the words “Connection Design” and replace with “details and information provided in the submitted drawings.”

Moreover, acceptance of the Drawings should follow the necessary checking and approval by the Engineer to all possible loads and stresses induced by the Contractor’s proposed method statement and calculations for lifting-up and erection. The Engineer is to ensure that stresses and forces due to lifting do not jeopardize the safety of any of the steel members or connection.

It is the Engineer’s prerogative to ask the Contractor to modify any of the lifting-up steps or position in order to secure the safety of the supporting steel structure.
4. **FABRICATION**

4.1 **GENERAL**

*Add the following sub-clauses 1 to 6:*

1. No fabrication work is to commence before approval of test reports and submittals.

2. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in shop Drawings.

3. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.

4. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.


6. Obtain permission of the Engineer before starting fabrication.

4.2.1 **Traceability of Steel**

*Amend the clause between brackets to read as follows:*

“(see Clause 2.1.4 and 2.1.5 of this Section)”

4.2.2 **Material Grade Identification**

*Amend sub-clause 1 to read as follows:*

The material grades of all steel shall be identifiable.

4.2.3 **Marking Steelwork**

*Add the following sub-clauses (4 and 5):*

4. Identify high-strength structural steel according to ASTM A 6M and maintain markings until steel has been erected.

5. Mark and match-mark materials for field assembly.

4.3.1 **General Requirements**

*Add the following sub-clauses (2 to 7):*

2. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.

3. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
(a) Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.

(b) Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

4. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not to delay work.

5. Manufactured items are to be delivered in original packages, containers etc. bearing name of manufacturer and brand. Each piece of material is to bear the official grade and trade mark of the association under whose rules it is graded or is to be accompanied by a certificate of inspection issued by that association.

6. Protect structural steelworks by approved adequate measures from constructional hazards during and after erection.

7. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

4.4.1 Cutting Operations

Delete sub-clause 1 and substitute with the following:

Perform thermal cutting my machine to greatest extent possible.

1. Plane thermally cut edges to be welded.

4.4.3 Columns

Add the following sub-clause (4):

Accurately mill ends of columns and other members transmitting loads in bearing.

4.7.1 Matching

Delete sub-clause 1 and substitute with the following:

1. Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members, as shown on Shop Drawings.

2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.

3. Weld threaded nuts to framing and other specialty items as indicated to receive other work.
4.7.2 Punching Full Size

*Delete Clause title and replace with the following:*

4.7.3 Distribution of Holes

*Delete sub-clause 1 completely and substitute with the following:*

1. Bolt field connections, except where welded connections or other connections are indicated.
2. do not distort or enlarge holes when using drifts
3. do not use drifts of large diameter than holes
4. report any misalignment of holes
5. reaming of holes will not be allowed except for minor connections and subject to written approval from the Engineer.

4.7.4 Punching and Reaming

*Delete entire clause.*

4.7.5 Slotted Holes

*Amend title number to be: 4.7.4*

4.8.1 General Requirements

*Add “and 4.7.3” to the end of sub-clause 2 inside the bracket*

4.9 CURVING AND STRAIGHTENING

*Add the following new clause:*

4.9.2 Steel Wall Framing

Select true and straight members for fabricating steel wall framing to be attached to structural steel framing. Straighten as required to provide uniform, square, and true members in completed wall framing.

4.10.1 General Requirements

*Add the following new sub-clause 2:*

Materials and workmanship are subject to inspection and test by the Engineer, who is to have access at all times to all parts of the workshop where steelworks is being fabricated and is to be provided with reasonable inspection facilities.
5. WELDING

5.1.2 References

**Delete all standards under sub-clause 1 and replace with the following:**


5.1.3 System Description

**Delete the words “metal arc” from the first line of sub-clause 1.**

**Delete the words “BS 5135 and BS 4570” from the first line of sub-clause 1 and replace with “AWS D1.1”.**

**Delete the words “BS 5135” from the first line of sub-clause 3 and replace with “AWS D1.1”.**

5.2.1 Testing

**Delete sub-clause 1 and replace with the following:**

Provide evidence of welder's competence to undertake specified work. Welders must have been tested to the Standard Code for Welding in Building Construction of the American Welding Society (AWS D1.1) using same electrodes class and welding positions which will be used in the work.

**Delete sub-clause 2 and replace with the following:**

1. Test Welders to the Standard Code of Welding in Building Construction of the American Welding Society when instructed using:

   (a) thickest plate specified and/or

   (b) material with highest carbon content

   (c) electrodes of appropriate class

   (d) welding positions which will be used in the work.

5.2.2 Certification

**Delete the words “for re-approval” from the first line of sub-clause 2.**

**Delete the words “BS EN 287 Part 1” from the end of sub-clause 2 and replace with “AWS D1.1”.**

5.3.1 Preparation Procedures

**Delete the words “BS 5135” from sub-clause 1 and replace with “AWS D1.1”.**

**Delete the words “BS EN 288 Part 3” from the end of sub-clause 1 and replace with “AWS D1.1”.**

5.4.1 Fit-Up
Delete the words “in Table 5.2” from the end of sub-clause 1 and replace with “as per the AWS D1.1”.

5.4.3 Tack Welds

Amend sub-clause 1 to read as follows:

Tack welds shall be made using the same procedures as for the root runs of main welds. The length of the tack shall be as per the requirements of the AWS D1.1.

Delete sub-clauses 2 and 3 entirely.

5.4.4 Distortion Control

Delete the word “minimized” at the end of sub-clause 1 and replace with “canceled”.

5.4.5 Fabrication or Erection Attachments

Delete sub-clause 2 and replace with the following:

Attachments shall not be removed by hammering
Removal of welds shall be done in accordance with the requirements of the AWS D1.1.

5.4.6 Extension Pieces

Delete entire clause and replace with the following:

5.4.6 Welded Construction

1. Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.

2. Unless shown on the drawings site welding will only be permitted for minor connections subject to written approval from the Engineer.

3. Do not place any welds, except those shown on the drawings, without approval even for temporary attachment and repair of faulty plates.

5.4.7 Production Test Plates

Delete entire clause and replace with the following:

5.4.7 Use of Run on and Run Off Plates

(a) Use run on and run off plates to ensure full throat thickness at ends of butt welds as follows:

(i) material for plates is to be identical to material being welded

(ii) prepare plates in same manner as parts being joined
(iii) size of run on and run off plates to be 75 mm x 75 mm
(iv) after completion of welding remove plates and grind surfaces of joined parts where plates are attached to make smooth
(v) retain and identify plates for inspection when requested.

5.4 ASSEMBLY

_Add the following new Clauses:_

5.4.8 Shop Weld Connections

1. Shop Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.

3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 13 mm and larger. Grind flush butt welds. Dress exposed welds.

5.4.9 Architecturally Exposed Structural Steel

1. Fabricate architecturally exposed structural steel with exposed surfaces smooth, square and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness.

2. Remove blemishes by filing, grinding, or by welding and grinding, prior to cleaning, treating, and shop priming.

3. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for architecturally exposed structural steel.

5.5 NON-DESTRUCTIVE TESTING OF WELDS

_Add the following new Clause (with sub-clauses 1 through 7):_

5.5.1 General

1. Contractor will engage an independent testing and inspecting agency to perform shop inspections and tests and to prepare test reports, subject to the engineer approval, on contractor expense.

(a) Testing agency will conduct and interpret tests and state in each report whether test specimens comply with or deviate from requirements.

(b) Provide testing agency with access to places where structural steel Work is being fabricated or produced so required inspection and testing can be accomplished.
2. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.

3. Additional testing, at Contractor’s expense, will be performed to determine compliance of corrected Work with specified requirements.

4. Testing agency may inspect structural steel at plant before shipment; however. Engineer reserves right, at any time before final acceptance, to reject material not complying with specified requirements. Retain above or below.

5. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

6. Perform visual inspection of all welds.

7. Perform non destructive tests of welds on 10% of all fillet weld lengths as a first testing round, depending on its results, the Engineer might instruct the Contractor to extend the testing process and/or to replace welder at no extra cost. Selection of tested samples to be approved by the Engineer. Non-destructive tests of butt welds to be done on 100% of the welded lengths.

5.5.1 Record Of Testing

Amend Clause number to be: 5.5.2

5.5.2 Visual Inspection of Welds

Amend Clause number to be: 5.5.3

Add the following to the beginning of sub-clause 1:

“During fabrication of structural steel assemblies, …”

Delete references in sub-clause 1 to “BS 5289” and “Tables 5.1 and 5.2” and replace with “AWS D1.1.”

Add the following new sub-clause 3:

Visual inspection should be performed for all (100%) of welds.

5.5.3 Surface Flow Detection

Delete entire Clause and replace with the following:

5.5.4 Fillet Welds

1. Fillet Welds:

   (a) Liquid Penetrant Inspection: ASTM E 165, or

   (b) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld of fillet welds at random. Cracks or zones of incomplete fusion or penetration not acceptable.
5.5.4 Ultrasonic Examination

Amend Clause title and number to read as follows:

5.5.5 Full Penetration and Partial Penetration Welds

Delete sub-clause 1 and replace with the following:

1. Butt Welds:

   (a) Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level “2-2T”, or,
   
   (b) Ultrasonic Inspection: ASTM E 164 for 100% of full penetration and partial welds.

Delete the words “final ultrasonic” from sub-clause 2 and replace with “non-destructive”.

5.5.5 Scope Of Inspection

Amend Clause number to be: 5.5.6

Delete reference to “Table 5.2” and replace with this part 5 for welding.

5.5.6 Acceptance Criteria and Corrective Action

Amend Clause number to be: 5.5.7

Delete reference to “Table 5.2” in sub-clause 1 and replace with “AWS D1.1”.

Delete sub-clause 2 entirely.

5.6.1 Method

Add the following to the end of sub-clause 1:

“... and as per the requirements of the AWS D1.1 for stud welding”.

Add the following new sub-clause 2:

Shear Connections: Prepare steel surfaces as recommended by manufacturer of shear connectors. Shop weld shear connectors, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer’s printed instructions.
5.6.3 Tests and Inspection

*Add the following new sub-clause 4:*

Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

5.6.4 Defective Studs

*Amend sub-clause 1 to read as follows:*

Studs with defective welding shall be removed and replaced and re-tested as per the requirements of the AWS D1.1.

**Tables 5.1 and 5.2**

*Delete Tables 5.1 and 5.2 entirely.*
6. BOLTING

6.1.2 References

*Delete all standards under sub-clause and replace with the following:*

- RCSC (Research Council on Structural Connections) “Specifications for structural joints using ASTM A490 Bolts”.

6.2.1 Bolt/Nut Combination

*Delete Clause entirely.*

6.2 ORDINARY BOLTED ASSEMBLIES

Based on the deletion of Clause 6.2.1, amend clause numbers of subsequent clauses accordingly.

6.2.7 Bolt Tightening

*Amend Clause number to be: 6.2.8*

*Add the following to the end of sub-clause 1:*

“… as per the requirements of the AISC and of the RCSC Specification.”

6.2.8 Fitted Bolts

*Delete Clause entirely.*

6.3.2 Reaming

*Delete sub-clause 1 and replace with the following:*

Do not distort or enlarge holes when using drifts. Reaming of holes will not be allowed except for minor connections subject to written approval from the Engineer.

6.4 HIGH STRENGTH FRICTION GRIP ASSEMBLIES

*Amend Clause title to read as follows:*

6.4 HIGH STRENGTH BOLT ASSEMBLIES

6.4.1 Bolt/Nut/Washer Combinations

*Delete Clause entirely.*
6.3 **FIT-UP WHEN USING ORDINARY BOLTS**

Based on the deletion of Clause 6.2.1, amend clause numbers of subsequent clauses accordingly.

6.4.2 **Tightening**

*Delete sub-clauses 1 and 2 and replace with the following:*

1. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 490 Bolts."

2. Conventional High strength bolts are to conform to ASTM A325 with diameter not more than 25mm

3. Anchor bolts are to conform to ASTM F1554 GR.36 with diameter not more than 25mm

4. Connection Type: Slip-critical, direct-tension, or tensioned shear/bearing connections as indicated.

6.4.3 **Calibration of Torque Equipment**

*Delete sub-clause 1 and replace with the following:*

Torque tightening equipment shall be calibrated in accordance with the requirements of the AISC and the RCSC Specifications.

6.5 **FIT-UP WHEN USING HSFG BOLTS**

*Amend title to read as follows:*

6.5 **FIT-UP WHEN USING HIGH-STRENGTH BOLTS**

6.5.2 **Reaming**

*Delete sub-clauses 1 and 2 and replace with the following sub-clauses:*

1. Do not distort or enlarge holes when using drifts.

2. Reaming of holes will not be allowed except for minor connections and subject to written approval from the Engineer.

*Add the following new Clauses:*

6.6 **TESTING OF HIGH STRENGTH BOLTS**

1. Contractor will engage an independent testing and inspecting agency to perform shop inspections and tests and to prepare test reports, subject to the engineer approval, on contractor expense.

2. Testing agency will conduct and interpret tests and state in each report whether test specimens comply with or deviate from requirements.

3. Provide testing agency with access to places where structural steel Work is being
fabricated or produced so required inspection and testing can be accomplished.

### 6.7 TESTING PROCEDURES FOR HIGH STRENGTH BOLTS

1. Shop-bolted connections will be tested and inspected according to AISC specifications and RCSC's "Specification for Structural Joints Using ASTM A 490 Bolts."

2. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.
7. ACCURACY OF FABRICATION

7.1.2 References

Delete all standards under sub-clause 1 and replace with the following:

AISC: Code of Standard Practice for Steel Buildings and Bridges


7.2.1 Permitted Deviations In Rolled Components After Fabrication

Add the following at the beginning of sub-clause 1:

Permitted deviation and tolerances during fabrication, lifting and erection shall be governed for the more stringent of the following two items.

Amend Table 7.1 as follows:

In Item 1, delete the reference “BS 4 or BS 4848” and replace with “AISC Manual of Steel Construction, AISC Code of Standard Practice for Steel Buildings and Bridges and the AWS Structural Welding code”.

In Item 2, amend the word “Bearrng” and replace with “Bearing”.

Add the following new sub-clause 2:

1. Maintain erection tolerances of structural steel within AISC’s “Code of Standard Practice for Steel Buildings and Bridges.”

8. ERECTION AND LIFTING-UP

Amend all references to ERECTION to read as ERECTION AND LIFTING-UP.

8.1.1 SCOPE

Add the following:

3. Related Parts and Sections are as follows:
   
   AISC: Code of Standard Practice for Steel Buildings and Bridges
   RCSC “Specification for Structural Joints using ASTM A490 bolts”
   Wind loads are in accordance with ASCE 7-05.

8.2.1 Erection and Lifting-Up

Insert the words “and lifting-up” space between the words “erection” and “procedure” in the second line of sub-clause 1.

Add the following clause 4

4. A proposed procedure for lifting-up is provided as part of the Contract Drawings.

8.2.2 Meaning of Acceptance

Amend title to read as follows:

8.2.2 Meaning of Acceptance, Examination and Preparation

Add the following sub-clauses 2, 3, 4 and 5:

2. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.

3. Do not proceed with erection until unsatisfactory conditions have been corrected.

4. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

5. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

6. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.
8.2.5 Damaged Steelwork

Add the word “lift-up” after “storage” in the first line of sub-clause 1.

8.2.6 COLUMN BASE PLATES AND SLABS

Delete sub-clauses 1, 2 and 3 and replace with the following:


2. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.

3. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.

4. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.
   (a) Comply with manufacturer’s instructions for proprietary grout materials.

8.6 SITE WELDING

Amend Clause title to read as follows:

8.6 ERECTION PROCEDURES

Delete Clause 8.6.1 entirely and replace with the following sub-clauses:

1. Splice members only where indicated.

2. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

3. Do not use thermal cutting during erection.

4. Finish sections thermally cut during erection equal to a sheared appearance.

5. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

6. Do not use welding equipment on site without approval.

7. Ensure bolts are in centre of slotted holes after erection of structure.

8. Treat sliding surfaces of proprietary joints in accordance with manufacture’s recommendations before connecting.

9. Raise or lower to correct level using sawn steel packs not larger than necessary for the purpose

10. Notify the Engineer when space beneath any column base is less than 10 mm or
more than 50 mm.

11. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

12. Ensure that the capacity of plant and equipment used for erection are suitable and are in first class working order.

13. Obtain permission before starting erection of steel work.

14. Inspect foundations before starting erection for line and level, anchor bolts for position, protruding length, condition and slackness.

Add the following new Clauses:

8.7 FIELD CONNECTIONS

8.7.1 Installation of High Strength Bolts

1. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 490 Bolts."

2. Bolts: ASTM A 490M high-strength bolts, unless otherwise indicated.

3. Connection Type: Slip-critical, direct-tension, or tensioned shear/bearing connections as indicated.

8.7.2 WELDED CONNECTIONS

1. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

2. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.

4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 13 mm and larger. Grind flush butt welds. Dress exposed welds.

8.8 FIELD QUALITY CONTROL

8.8.1 General

1. Contractor shall engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports at the Contractor’s expense.

2. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
8.8.2 Correct Deficiencies

1. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.

8.8.3 Additional Testing

1. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

8.8.4 Field-Bolted Connections

1. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 490 Bolts."

2. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.

8.8.5 Field Welding

Field Welding: Inspect and test during erection of structural steel as follows:

1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

2. Perform visual inspection of all welds.

3. Perform non destructive tests of welds on 10% of all fillet weld lengths as a first testing round, depending on its results, the Engineer might instruct the Contractor to extend the testing process and/or to replace welder at no extra cost. Selection of tested samples to be approved by the Engineer. Non-destructive tests of butt welds to be done on 100% of the welded lengths.

Fillet Welds

(a) Liquid Penetrant Inspection: ASTM E 165, or,

(b) Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld of fillet welds at random. Cracks or zones of incomplete fusion or penetration not acceptable.

Butt Welds

(a) Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T", or,

(b) Ultrasonic Inspection: ASTM E 164 for 100% of full penetration and partial welds.

8.8.6 Weld Defects

1. Weld defects: cracks, overlaps, lack of penetration or incomplete fusion shall not be allowed.
8.8.7  Lamination Tests

1  Lamination tests: carry out ultrasonic testing for lamination on all head plates for moment connections (15 mm thick or above) in accordance with DIN 54120 or ASTM E164.

8.8.8  Non-Shrink Grout

1  Non-shrink grout: prepare 50 mm cubes and test for compressive strength in accordance with ASTM C109.

8.8.9  Field-Welded Shear Connectors

1  In addition to visual inspection, field-welded shear connectors will be inspected and tested according to requirements of AWS D1.1 for stud welding and as follows:

   (a)  Bend tests will be performed when visual inspections reveal either less than a continuous 360-degree flash or welding repairs to any shear connector.

   (b)  Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested, according to requirements of AWS D1.1.

8.8.10  Tolerances

1  Tolerances: The permissible deviation of fabricated and erected structures are to be in accordance with the limitations of the AISC.

8.8.11  Equipment

1  Equipment: provide necessary facilities and equipment for specified tests in the fabrication shop and on site. Calibrate load measuring equipment at regular intervals agreed with Engineer.

8.8.12  Results

1  Results: submit three copies of test and examination results to Engineer immediately they are available.
9. **ACCURACY OF ERECTED AND LIFTED-UP STEELWORK**

*Amend all references to ERECTION to read as ERECTION AND LIFT-UP.*

9.1 **GENERAL**

*Add new clause as follows:*

9.1.3 **References**

- AISC: Code of Standard Practice for Steel Buildings and Bridges

9.3.1 **Permitted Deviations for Foundations, Walls and Foundation Bolts**

*Add the following at the beginning of sub-clause 1:*

Permitted deviation and tolerances during lifting-up and erection shall be governed by the most stringent of the following two items.

*Add the following new sub-clause 2:*

Delete Part 10 completely and replace with the following:

10. PROTECTIVE TREATMENT

10.1 SHOP PRIMING

10.1.1 Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 50 mm.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed-on fireproofing. For extent of steel subject to sprayed on fire protection reference is made to the Architectural specs and drawings.
5. Galvanized surfaces.

10.2 PAINT APPLICATION

1 Apply all specified coats of paint to surfaces which are inaccessible after assembly or erection. Change color of successive coats to distinguish them from previous ones.

10.3 SURFACE PREPARATION:

1 After inspection and before shipping, clean steelworks to be painted. Remove loose rust, loose mill scale, and spatter, slag or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) to SP-10 "Near - White Blast Cleaning" (equivalent to SA 2 1/2).

10.4 PAINTING OF STEEL PRIMER:

1 Immediately after surface preparation (in any case within four hours), apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide the specified dry film thickness. Use painting methods which result in full coverage of joints, corners, edges and exposed surfaces.

10.5 PAINTING OF PART COATINGS:

1 Provide all paint coatings in shop except the final finish coat (which has to be applied after erection) all in accordance with the requirements of the Steel Structure Painting Council (SSPC), as per manufacturer's recommendation.

10.6 GUARANTEE

1 Provide a written guarantee that the protective coating system, intumescent paint system and primer proof sprayed surfaces on steel work will give a minimum life to first maintenance of 15 years in the climatic conditions prevailing on site and for the exposure of the steel work.
10.7 **GALVANIZING**

1. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A 123.

10.8 **CLEANING**

10.8.1 **Touchup Painting**

1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

2. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils (0.038 mm).

3. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on structural steel are included in Section 26."

10.8.2 **Galvanized Surfaces**

1. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

10.9 **INTUMESCENT PAINT**

1. Intumescent Paint System: is to be self-destructive, fire retardant, water-reducible or solvent-reducible, pigmented, semi-gloss coating. Provide manufacturer’s best-quality intumescent paint materials with 25 or less flame spread and smoke developed indices as determined by testing identical products per ASTM E84 in a testing and inspection agency acceptable to the Engineer. Intumescent paint system shall be high performance, high build, solvent free fire proofing coatings that provides fire rating of 120 minutes when tested according to ASTM E119. In addition to the fire proofing characteristics, intumescent paint system is to give the life to first maintenance against corrosion between 15 to 20 years taking into consideration climatic conditions on site and exposure of the steelwork to be used only when specified by Architectural drawings/documentations.

2. Provide compatible finish topcoat with color and texture as selected by … Engineer from manufacturer's full range.

3. Warranty for intumescent paint system:

   (a) Special Warranty for paint finishes: Provide complete system warantee in which Manufacturer, Contractor and Installer are jointly and severally responsible and agree to repair or replace without limitations, all or any part of paint coatings that fail in materials or workmanship within the specified guarantee period. Contractor and Manufacturer shall reimburse the Employer for the cost of material and labor. Failures include, but are not limited to:

   (b) Peeling or blistering of paint film.

   (c) Failure to protect against corrosion.
(d) Failure to protect against fire for the specified time
(e) Cracking of paint film.
(f) Craze of paint film
(g) Efflorescence.
(h) Change in color.
(i) Staining.
(j) Patchiness of sheen or color.

4 Warranty Period for Paint Coatings:

(a) Warranty for the life of the first maintenance of the paint system to satisfy the life to first maintenance of 20 years against corrosion.

(b) Warranty for the life of the first maintenance for the intumescent layer itself to first maintenance of 5 years against fire.
Add new part 11:

11. STEEL DECK

11.1 GENERAL

11.1.1 Related Documents

Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

11.1.2 Summary

This Section includes the following:

(a) Roof deck.
(b) Composite floor deck.

Related Sections include the following:

(a) Section 16 "Structural Steelwork"

11.1.3 Submittals

1 Product Data: For each type of deck, accessory, and product indicated.

2 Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.

3 For steel deck indicated to comply with certain design loadings, include structural analysis data sealed and signed by the qualified professional engineer who was responsible for its preparation.

4 Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.

5 Welding Certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

6 Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:

(a) Mechanical fasteners.

7 Research/Evaluation Reports: Evidence of steel deck’s compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

8 As-Built Drawings: At project close-out, submit record “As-Built” drawings of completed work products, in accordance with requirements of the Specification as indicated in Division 1.
11.1.4 Quality Assurance

1. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

2. Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

3. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency shall demonstrate to Engineer's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

   (a) Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

5. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.
   (a) Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or by Warnock hersey or another testing and inspecting agency.
   (b) Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

6. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

11.1.5 Delivery, Storage, and Handling

1. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

2. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

11.2 PRODUCTS

11.2.1 Roof Deck

1. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 28, and the following:
   (a) Galvanized Steel Sheet: ASTM A 611, Grade D minimum, zinc coated
acording to ASTM A 525M.

(b) Galvanized Steel Sheet: ASTM A 446, Grade A, Z 275 zinc coated according to ASTM A 525M.

(c) Profile Depth: as indicated on drawings.

(d) Design Uncoated-Steel Thickness: As indicated on drawings.

11.2.2 Composite Floor Deck

1. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 28, the minimum section properties indicated, and the following:

(a) Profile Depth: 50mm unless otherwise indicated on drawings.

(b) Design Uncoated-Steel Thickness: As indicated on drawings.

11.2.3 Accessories

1. General: Provide manufacturer's standard accessory materials for steel deck that comply with requirements indicated, and recommendations of the steel deck manufacturer.

2. Mechanical Fasteners: Manufacturer Standard, Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

3. Side-Lap Fasteners: Manufacturer Standard, Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, 4.8 mm minimum diameter.


5. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 230 MPa, not less than 0.91-mm design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

6. Steel Sheet Accessories: ASTM A 446M, 2180 coating class, galvanized according to ASTM A 525M, G60.

7. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 230 MPa, of same material and finish as deck, and of thickness and profile indicated.

8. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.


10. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 1.90 mm thick, with factory-punched hole of 9.5-mm minimum diameter.

11. Recessed Sump Pans: Single-piece steel sheet, 1.80 mm thick, of same material and finish as deck, with 76-mm wide flanges and level recessed pans of 38-mm
minimum depth. For drains, cut holes in the field.

12. Flat Sump Plate: Single-piece steel sheet, 1.80 mm thick, of same material and finish as deck. For drains, cut holes in the field.


14. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.


16. Preset Inserts: Manufacturer’s standard, UL-labeled single-piece preset inserts, fabricated from either steel sheet galvanized according to ASTM A 525M, Z 180 coating class, or zinc sheet, with removable covers.

11.3 EXECUTION

11.3.1 Examination

1. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance, of steel deck.

11.3.2 Preparation:

1. Do not place deck panels on concrete supporting structure until concrete has cured and is dry.

2. Locate decking bundles to prevent overloading of supporting members.

11.3.3 Installation, General

1. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 28, manufacturer’s written instructions, and requirements in this Section.

2. Install temporary shoring before placing deck panels, if required to meet deflection limitations.

3. Locate decking bundles to prevent overloading of supporting members.

4. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

5. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

6. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.

7. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.
8. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

9. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

11.3.4 Roof Deck Installation

1. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter, but not less than 38 mm long, and as follows:
   (a) Weld Diameter: nominal.
   (b) Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support.

2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span and as follows:
   (a) Mechanically fasten with self-drilling carbon-steel screws.

3. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

4. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

11.3.5 Floor Deck Installation

1. Fasten floor deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   (a) Weld Diameter: nominal.
   (b) Weld Spacing: Weld edge ribs of panels at each support.

2. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 910 mm, and as follows:
   (a) Mechanically fasten with self-drilling carbon-steel screws.

3. Shear Connectors: Weld shear connectors through deck to supporting frame according to AWS D1.1 and manufacturer's written instructions. Butt end joints of deck panels; do not overlap. Remove and discard arc shields after welding shear connectors.
4. **Pour Stops and Girder Fillers**: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

5. **Floor Deck Closures**: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

### 11.3.6 Field Quality Control

1. **Testing**: Contractor will engage a qualified independent testing agency to perform field quality-control testing, subject to the engineer approval, on contractor expense.

2. Field welds will be subject to inspection as per specification.

3. Shear connector stud welds will be inspected and tested according to AWS D1.1 for stud welding and as follows:
   
   (a) Shear connector stud welds will be 100% visually inspected.
   
   (b) Bend tests will be performed if visual inspections reveal less than a full 360-degree flash or welding repairs to any shear connector stud.
   
   (c) Tests will be conducted on additional shear connector studs if weld fracture occurs on shear connector studs already tested according to AWS D1.1.

4. Testing agency will report test results promptly and in writing to Contractor and Engineer.

5. Remove and replace work that does not comply with specified requirements.

6. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

### 11.3.7 Repairs and Protection

1. **Galvanizing Repairs**: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

2. **Repair Painting**: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint as per painting application requirements.
   
   (a) Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.

3. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.
SECTION 17

METALWORK
1. GENERAL

1.1 INTRODUCTION

1.1.1 Scope

Amend to be read as follows:

1 This Part provides the specification for preparation of shop drawings, engineering, testing, fabrication, delivery erection and installation of steel doors, aluminium doors, windows and fly screens, aluminium support and architectural metal work.

1.1.2 Reference

Amend Standard BS 729 to the following:

- BS EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

Amend Standard BS 1474 to the following:

- BS EN 755 Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles

Amend Standard BS 1723 to the following:

- BS EN 14324 Brazing. Guidance on the application of brazed joints

Amend Standard BS 2994 to the following:

- BS EN 10162 Cold rolled steel sections. Technical delivery conditions. Dimensional and cross-sectional tolerances

Amend Standard BS 4147 to the following:

- BS EN 10300 Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating

Amend Standard BS 4254 to the following:

- BS EN ISO 11600 Building construction. Jointing products. Classification and requirements for sealants

Amend Standard BS EN ISO 10142 to the following:

- BS EN 10327 Continuously hot-dip coated strip and sheet of low carbon steels for cold forming. Technical delivery conditions
1.2 SUBMITTALS

1.2.4 Engineering Calculations

Add the following new paragraph:

4. The Contractor shall submit calculation notes for any metal system indicated to demonstrate compliance with performance requirements of referenced codes, standards and safety requirements.

1.2.7 Shop Drawings

Add the following new paragraphs:

2. Contractor shall submit shop drawings to detail fabrication and erection of each metalwork indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

3. Provide templates for anchors and bolts specified for installation under other Sections.

Add the following new sub-clause:

1.2.10 Welding Certificates

1. The Contractor shall submit copies of certificates for welding procedures and personnel.
2. MATERIAL TYPES AND FINISHES

2.3 ALUMINIUM FINISHES

2.3.2 Finishes for Aluminium and Aluminium Alloys

Delete the entirety paragraph and replace with following:

1. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

(a) Color and Gloss: As selected by Engineer from manufacturer's full range.

2. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

(i) Deterioration includes, but is not limited to, the following:

1) Colour fading more than 5 Hunter units when tested according to ASTM D 2244.

2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.

3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.

(ii) Warranty Period: 25 years from date of Substantial Completion.

3. Applicator Qualifications: A firm or individual who is approved by PVDF manufacture and has at least 10 years-experience in applying PVDF similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
3. METAL DOORS AND WINDOWS

3.1 ALUMINIUM DOORS AND WINDOWS

Amend title of sub-clause 3.1.3 to be Aluminium Works, Generally, as indicated hereafter.

3.1.3 Aluminium Works, Generally

Delete in its entirety paragraph no. 1 and replace with the following:

1 Shall be fabricated to details indicated on Drawings to comply with requirements specified. Aluminium alloy and temper shall be as recommended by manufacture for strength, corrosion resistance, shape of aluminium type and required application and finish but not less that alloy and temper 6063T5 for straight extrusions and 6063T4 for curved extrusions, unless otherwise superior alloy and temper are recommended by the manufacture.

Amend paragraph number 7 to read as follows:

7 The wall thickness of main web of aluminium door leafs and window sashes shall not be less than 2.00 mm. Wall thickness for opening frame section shall match the leaf or sash. Covers, beads and other secondary sections shall be 1.50 mm thick minimum. Frames to be self-draining and no holes for fastenings are to be located in the external channel at sill level.

(a) Overall door thickness is 44 mm, unless otherwise indicated on Drawings.

(b) Aluminium sections for doors are to be wide-style (101.60 mm wide), unless otherwise indicated on Drawings.

Amend paragraph number 8 to read as follows:

8 All openings are to be fully weather-stripped using the following types:

(a) Sliding weather stripping shall be woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Provide weather stripping with integral barrier fin or fins of semi-rigid polypropylene sheet or polypropylene-coated material. Provide special grooves in aluminium sections for locking of sliding weather stripping.

(b) Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when aluminium window is closed.

(i) Weather-Stripping Material: Dense elastomeric gaskets complying with BS EN 12365 requirements fabricated from EPDM.

(c) Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.

(d) Horizontal-Sliding Windows: Provide operable sash with a double row of sliding weather stripping in horizontal rails and single- or double-row
weather stripping in meeting or jamb stiles, as required to meet specified performance requirements. Provide compression-type weather stripping at perimeter of each movable panel where sliding-type weather stripping is not appropriate.

(e) Aluminium Door Frames: Reinforce as required to support loads imposed by door operation and for installing hardware.
   (i) At exterior doors, provide compression weather stripping at fixed stops.
   (ii) At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

(f) Aluminium Doors: Reinforce doors as required for installing hardware.
   (i) At pairs of exterior doors, provide sliding weather stripping retained in adjustable strip mortised into door edge.
   (ii) At exterior doors, provide weather sweeps applied to door bottoms.

Add the following at the end of paragraph no. 10:

(a) “Hardware to be designed to smoothly operate, tightly closed, and securely lock aluminium works and sized to accommodate sash or ventilator weight and dimensions. Cadmium-plated hardware is not permitted. Do not use aluminium in frictional contact with other metals. Where exposed, provide extruded, cast, or wrought aluminium and of same finish as elevations. Provide heavy-duty hardware in size, number and type as recommended by manufacturer, but not less than requirements of this Clause. Hardware shall comply with BS EN 1670.”

(b) Hardware for aluminium windows is to include the following as minimum requirement according to window movement type:
   (i) Hinges shall be aluminium, heavy-duty, five-knuckle butt hinge with nylon bushings, of suitable size and certified by manufacturer as suitable for window sash weight. Comply with BS EN 1935.
   (ii) Limit device shall be concealed support arms with adjustable, limited, hold-open limit device to limit clear opening to 150 mm for ventilation; with custodial key release.
   (iii) Locks and latches shall be designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Locks for doors shall be narrow stile, key-operated complete with stainless steel cylinders.
   (iv) Roller Assemblies: Low-friction design.
   (v) Sash Rollers: Stainless-steel, lubricated ball-bearing rollers with nylon tires.
   (vi) Push-Bar Operators: Provide type, push-bar operator designed to open and close ventilators with fixed screens.
   (vii) Concealed components of hardware and operating systems are to be
from stainless steel.

(viii) Sill Cap/Track: Extruded-aluminium with finish matching that of window track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.

(ix) Hardware Installation: Factory install hardware to the greatest extent possible. Cut, drill, and tap for factory-installed hardware before applying finishes.

(c) Hardware for aluminium/glass doors is to include the following as minimum requirement:

(i) Hinges: Ball-bearing butts, EN 1935, five-knuckles stainless steel pins, with non-removable pins at hinges exposed on outside of door. Provide 3 hinges at each door leaf up to 914.00 mm wide and 2023 mm tall and provide four hinges at each leaf for taller doors.

(ii) Push & Pull Handles: As indicated on Drawings or selected by the Engineer from manufacturer’s full range.

(iii) Dead locks: As specified in Section 18 of the Specifications.

(iv) Cylinders: Stainless steel, as specified in Section 18 of the Specifications.

(v) Face Strikes: Flat type, manufacturer’s standard aluminium with matching finish complete with mounting plate and plastic dust box, of matching colours.

(vi) Closers: Comply with manufacturer’s recommendations for closer size, depending on door size, exposure to weather, and anticipated frequency of use. Comply with requirements specified in Section 18.

(vii) Weather Sweeps: Manufacturer’s standard nylon brush sweep to underside of door bottom.


(ix) Locks: Install manufacturer’s standard pull and keyless locking device on each movable panel, lockable from the inside only. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

**Delete in its entirety paragraph no. 11 and replace with the following:**

11 Performance Requirements: Refer to Clause 3.1.4 of this Part

**Add the following at the end of paragraph number 15:**

“Unless otherwise indicated on Drawings”.

**Add the following new paragraphs:**

18 Sub-frames shall be aluminium box sections of 1.50 mm minimum wall thickness and mill finish, unless otherwise exposed to view from backside, shall be of matching finish as aluminium door or window.

19 Main Frames: Provide for main frame aluminium sections with integral architrave
extended onto internal (inside) wall surface of adjoining jamb to conceal separation line between wall and frame.

20 Provide screw-applied or snap-on glazing stops, coordinated with glass selection and glazing system indicated. Finish to match aluminium units.

21 Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.

22 Pre-glazed aluminium units at the factory where possible and practical for applications indicated. Comply with glass and glazing requirements of Section 25 “Glass and Glazing”.

23 Nonmetallic, Shrinkage-Resistant Grout: Premixed, centreline, noncorrosive, nonstaining grout; of consistency suitable for application.

24 Fasteners and Accessories: Aluminium or nonmagnetic stainless steel, manufacturer’s standard.

(a) Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.

(b) Reinforce members as required to receive fastener threads.

(c) Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system or fabricated from stainless steel as selected by Engineer.

25 Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

26 Gaskets and Weather-stripping: Solid chloroprene or EPDM.

27 Sealant: For manufacturing elevations is to be type permanently elastic, non-shrinking and non-migrating to comply with EN ISO 11600.

28 Finish: PVDF, comply with requirements as specified in Part 2 of this Section

**Add the following new sub-clauses:**

3.1.4 **Performance Requirements**

1 Provide aluminium types engineered, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading without failure, as demonstrated by testing manufacturer’s standard type assemblies representing types, grades, classes, and sizes required for Project according to test methods indicated.

2 Standards: Provide aluminium types complying with: BS 6375: Part 1 for watertightness and BS 6375: Part 2 for operation and strength.

3 Test Criteria: Testing shall be performed by a qualified independent testing agency based on the following criteria:
(a) Design wind pressure: Base design pressures as per ASCE 7: 2005 wind velocity of 45 m/sec. Allow for impact, suction, up-lift and gusting of wind and take into account the building height and the proximity of adjacent buildings, which could cause an increase to the forces due to the venturi effect.

(b) Heights of type units above grade at type centreline are indicated on or can be determined from the Drawings. Consult with the Engineer, if necessary, to confirm required loading and test pressures.

(c) Test Procedures: Test type units according to
   (i) BS EN 1026: For air permeability
   (ii) BS EN 1027: For water tightness
   (iii) BS EN 12211: For wind resistance.

4 Aluminium Types Classification: Unless otherwise calculations according to wind load criteria specified in paragraph 3 of this sub-clause demonstrates a higher design wind pressure, aluminium types used for the Project shall be tested and classified as suitable for the following

(a) Air Permeability: 600 Pa.
(b) Watertightness: 600 Pa.
(c) Resistance to Wind: Exposure Category 2000 Pa, minimum.

5 Endurance: Class 3 (Heavy Duty – 20,000 test cycles), according to BS EN 12400.

6 Thermal Transmittance: Provide aluminium windows with a whole-window U-value not exceed U-value specified for glass insulating units specified in Section 25 “Glass and Glazing”. Comply with BS 4873.

7 Thermal Movements: Provide type units that allow thermal movement resulting from the following maximum change (range) in ambient temperature when engineering, fabricating, and installing aluminium types to prevent buckling, opening of joints, and overstressing of components, connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to solar heat gain and night-time sky heat loss.

   (a) Temperature Change (Range): 50 deg C ambient; 70 deg C material surfaces.

8 Minimum weighted sound reduction index (Rw) to BS EN ISO 717-1: 35

3.1.5 Warranty

1 Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace aluminium windows and doors that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

   (a) Failure to meet performance requirements.
(b) Structural failures including excessive deflection.
(c) Water leakage, air infiltration, or condensation.
(d) Faulty operation of movable sash and hardware.
(e) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
(f) Insulting glass failure.

2 Warranty Period: Two years from date of Substantial Completion.

3.1.6 Smoke Vent Windows

1 Provide window operating system of the type and in groups as indicated. Coordinate operating system design with window fabrication and hardware selection to ensure smooth, durable operation of ventilators.

(a) Operation Function: The system shall be designed to open specific vents installed within the glazed facade in the event of a fire. These vents will naturally ventilate areas in order to prevent a build-up of smoke and noxious gases. The system will be interfaced with the fire alarm system and the system shall be fully automatic. The system will include Fireman’s Override Switches for ultimate control and system reset. All wiring for the system shall be fire rated.

(i) Fully tested and certified bottom hung automatically opening smoke ventilator CE marked to EN12101-2 for use in facades.

(ii) Smoke Vent Windows shall open in a controlled manner (at a rate equal to that of the closing operation), when activated by a fire alarm signal.

(b) Operation: Electric with a factory-assembled electric operator designed for operating windows of type, size, weight, construction, use, and operating frequency required.

(i) Electric Operator: Provide operation system; of size and capacity and with features, characteristics, and accessories suitable for Project conditions, recommended in writing by window manufacturer; and complete with operating system indicated, electric motor and factory- prewired motor controls with limit switches, remote-control stations, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation. Include wiring from motor controls to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

(ii) Control Equipment:

1) The control panel will be modular in construction and contain standard components

2) The control panel shall be interfaced with the actuators via hard wiring to enable centralised system control from the Fireman’s Override Switch
3) The control panel shall be equipped by a green LED to indicate the Power Supply Unit in the on mode.

4) The control panel will be modular in construction and contain standard components. The control panel shall be supplied by a suitably rating of the Power Supply to operate all of the Smoke Vent Windows under its control simultaneously and shall have a secondary power supply in case of failure of the normal supply. The secondary supply shall contain emergency backup battery to operate all of the Smoke Vent Windows under its control simultaneously and to maintain the system fully operational for a minimum of 24 hours, whilst allowing 10 operations during this period. Batteries shall be free maintenance and shall have a serviceable life for a period of not less than 5 years.

5) The Power Supply Unit shall deliver 24V DC output to the actuators via 4/8 separate fused outputs. These can be individually controlled by separate inputs. The control panel shall contain auxiliary outputs for supplying the control circuitry. The unit is designed to comply fully with the requirements of EN6095

(iii) Electric Motor: Thermal-overload protection; sized to start and operate size and weight of window sash ventilators under any conditions; one per each gear box shaft.

(iv) Motor Characteristics: As recommended by manufacture, comply with requirements as specified in Section 21.

(v) Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop sash ventilators at fully opened and fully closed positions.

3.4 FIXING ALUMINIUM WINDOWS AND DOORS

Amend paragraph number 5 to read as follows:

5 Surfaces of aluminium sub-frames that will come in contact with concrete or masonry shall be protected with bitumen-based cold-applied coating or approved protective tape.

Add the following new paragraph 9:

9 Installation of aluminium doors shall comply with applicable requirements of paragraphs 1 through 8 of this sub-clause.

(a) Erection Tolerances: Install aluminium-framed systems to comply with the following maximum tolerances:

(i) Location and Plane: Limit variation from true location and plane to 3 mm in 3.7 m; 6 mm over total length.

(ii) Alignment:

1) Where surfaces abut in line, limit offset from true alignment to 1.5 mm.

2) Where surfaces meet at corners, limit offset from true alignment to
0.8 mm.

(iii) Diagonal Measurements: Limit difference between diagonal measurements to 3 mm.

3.5 STEEL DOORS AND WINDOWS

Delete its entirely content and replace with the following clause:

3.5.1 Summary

1 This Part includes the following:
   
   (a) Steel doors and frames for interior and exterior applications
   (b) Fire rated steel doors.

3.5.2 Submittals

1 Product Data: Include construction details, material descriptions, core descriptions, label compliance, sound and fire-resistance ratings, and finishes for each type of door and frame specified.

2 Shop Drawings: Include the following:
   
   (a) Elevations of each door design.
   (b) Details of doors, including vertical and horizontal edge details and metal thicknesses.
   (c) Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   (d) Locations of reinforcement and preparations for hardware.
   (e) Details of each different wall opening condition.
   (f) Details of anchorages, joints, field splices, and connections.
   (g) Details of accessories.
   (h) Details of mouldings, removable stops, and glazing.
   (i) Details of conduit and preparations for power, signal, and control systems.

3 Samples for Initial Selection: For units with factory-applied colour finishes.

4 Door Schedule: Submit schedule of doors and frames using same reference numbers for details and openings as those on Drawings.
   
   (a) Coordinate glazing frames and stops with glass and glazing requirements.

5 Samples for Verification:
   
   (a) For each type of exposed finish required, prepared on Samples of not less than 75 by 125 mm.
   (b) For the following items, prepared on Samples about 305 by 305 mm to demonstrate compliance with requirements for quality of materials and construction:
(i) Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.

(ii) Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow metal panels and glazing if applicable.

6 Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

7 Oversize Construction Certification: For door assemblies required to be fire rated and exceeding limitations of labelled assemblies, submit certification of a testing agency acceptable to authorities having jurisdiction that each door and frame assembly has been constructed to comply with design, materials, and construction equivalent to requirements for labelled construction.

8 Qualification Data: For manufacture/fabricator and installer.

   (a) For firms and persons specified in “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and employers, and other information specified.

3.5.3 Quality Assurance

1 Manufacturer Qualifications: A firm experienced in manufacturing custom steel doors and frames similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

2 Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

3 Source Limitations: Obtain custom steel doors and frames through one source from a single manufacturer.

4 Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labelled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

   (a) Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to authorities having jurisdiction that doors comply with standard construction requirements for tested and labelled fire-rated door assemblies except for size.

   (b) Temperature-Rise Rating: If indicated, provide doors that have a temperature-rise rating of 250 deg C maximum in 30 minutes of fire exposure.

5 Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.
3.5.4 Delivery, Storage, and Handling

1 Deliver doors and frames palleted, wrapped, or crated to provide protection during transit and Project site storage. Do not use nonvented plastic.

   (a) Provide additional protection to prevent damage to finish of factory-finished doors and frames.

2 Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

3 Store doors and frames under cover at building site. Place units on minimum 100-mm-high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.

   (a) If wrappers on doors become wet, remove cartons immediately. Provide minimum 6-mm spaces between stacked doors to permit air circulation.

3.5.5 Warranty

1 Door Manufacturer's Warranty: Provide complete warranty in which Manufacturer, Contractor and Installer are jointly and severally responsible and agree to repair or replace without limitations, all or any part of defective doors that do not fulfil quality and performance requirements or do not comply with tolerances in referenced quality standard such as, but not limited to:

   (a) Structural failures.
   (b) Faulty operation of movable parts and hardware.
   (c) Deterioration of metals, and other materials beyond normal weathering.
   (d) Warranty shall also include all hardware.

2 Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.

3 Warranty Period: Ten years from date of Substantial Completion.

4 Warranty Period of Finishes: Comply with requirements as specified in this Section Part 2.

3.5.6 Project Conditions

1 Field Measurements: Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.

   (a) Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating custom steel frames without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.
3.5.7 Coordination

1 Coordinate installation of anchorages for custom steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

3.5.8 Materials

1 Metallic-Coated Steel Sheets: ASTM A 653/A 653M, CS (commercial steel), Type B; with G60 (Z180) zinc (galvanized).

2 Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

3 Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.

(a) For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

4 Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, zinc coat according to ASTM A 153/A 153M, Class C or D as applicable.

5 Glass for Vision Panels: Type as indicated on Drawings and specified in Section "Glass and Glazing".

6 Grout: Comply with ASTM C 476, with a slump of 102 mm for custom steel door frames built into concrete or masonry, as measured according to ASTM C 143/C 143M.

7 Mineral-Fibre Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibres manufactured from slag or rock wool with 96- to 192-kg/cu. m density; with maximum flame-spread and smoke-developed indexes of 25 and 50 respectively; passing ASTM E 136 for combustion characteristics.

3.5.9 Standard Hollow Metal Doors

1 General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.

(a) Design: As indicated.

(b) Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polysisocyanurate, mineral-board, or vertical steel-stiffener core.

(i) Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

(ii) Thermal-Rated Insulated Doors: Where indicated, provide doors fabricated with thermal-resistance value R-value of not less than
2.166 K x sq. m/W when tested according to ASTM C 1363.

(c) Locations: Exterior doors and interior doors where indicated.

(i) Vertical Edges for Single-Acting Doors: Square edge unless bevelled edge is indicated.
   a) Bevelled Edge: 3.0 mm in 50 mm.

(d) Vertical Edges for Double-Acting Doors: Round vertical edges with 54 mm radius.

(e) Top and Bottom Edges: Closed with flush or inverted 1.0 mm thick, end closures or channels of same material as face sheets.

(f) Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

2 Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

(a) Level 4 and Physical Performance Level A (Maximum Duty), Model 1 (Full Flush).

3 Interior Doors: Face sheets fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior door requirements. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

(a) Level 3 and Physical Performance Level A Extra-Heavy Duty, Model 1 Full Flush.

4 Hardware Reinforcement: Fabricate reinforcement plates from same material as door face sheets to comply with the following minimum sizes:

(a) Hinges: Minimum 3.0 mm thick by 38 mm wide by 152 mm longer than hinge, secured by not less than 6 spot welds.

(b) Pivots: Minimum 4.2 mm thick by 38 mm wide by 152 mm longer than hinge, secured by not less than 6 spot welds.

(c) Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 1.7 mm thick.

(d) All Other Surface-Mounted Hardware: Minimum 1.7 mm thick.

5 Fabricate concealed stiffeners and hardware reinforcement from either cold or hot-rolled steel sheet.

3.5.10 Fire Rated Doors

1 Fire Doors: Fire resisting doors, as indicated on the Drawings, satisfying the requirements of ASTM E 2074 and NFPA 80; flush fitting steel construction with welded internal frame, inner and outer skins galvanized steel sheets and infill of approved thermal insulating material complete with frame, vision panel, fire resisting hardware, and all necessary accessories and fixings. Raised thresholds are not permitted.
(a) Provide intumescent strips either on door edges or on the door frame where required by the relevant codes and standards.

(b) Doors are to be self-closing and are to be released automatically from hold-open position in case of fire by electromagnetic devices connected to fire alarm system.

(c) All single doors and active leaves of pairs of doors shall be provided with an active latch bolt that cannot be held in a retracted position as specified in the individual manufacturer’s published listings.

(d) Where there is an astragal or projecting latch bolt that prevents the inactive door from closing and latching before the active door closes and latches, a coordinating device shall be used.

3.5.11 Standard Hollow Metal Frames

1 General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.


(a) Fabricate frames with mitred or coped and welded face corners and seamless face joints.

(b) Frames for Level 4 Steel Doors: 1.7-mm-thick steel sheet.

3 Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated

(a) Fabricate frames with mitred or coped and welded face corners and seamless face joints.

(b) Frames for Level 3 Steel Doors: 1.3 mm thick steel sheet.

(c) Frames for Borrowed Lights: Same as adjacent door frame.

(d) Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

3.5.12 Frame Anchors

1 Jamb Anchors:

(a) Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 1.0 mm thick, with corrugated or perforated straps not less than 50 mm wide by 250 mm long; or wire anchors not less than 4.5 mm thick.

(b) Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 1.0 mm thick.

(c) Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.

(d) Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 9.5 mm diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
2 Floor Anchors: Formed from same material as frames, not less than 1.0 mm thick, and as follows:

(a) Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

3 Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 50 mm height adjustment. Terminate bottom of frames at finish floor surface.

3.5.13 Stops and Mouldings

1 Mouldings for Glazed Lites in Doors: Minimum 0.8 mm thick, fabricated from same material as door face sheet in which they are installed.

2 Fixed Frame Mouldings: Formed integral with standard steel frames, minimum 16 mm high, unless otherwise indicated.

3 Loose Stops for Glazed Lites in Frames: Minimum 0.8 mm thick, fabricated from same material as frames in which they are installed.

3.5.14 Louvers

1 Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.5 mm thick, cold-rolled steel sheet set into 0.8 mm thick steel frame.

(a) Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other, any angle.

(b) Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labelled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same testing and inspecting agency that established fire-resistance rating of door assembly.

3.5.15 Steel Louvered Door

1 General: Are to heavy-duty construction, stile-and-rail door leaves with prefabricated framed steel louver panels welded flush with stiles and rail of the door leaves.

(a) Stiles and rails are to be of tubular construction with sound deadening core material. Stiles and top rail are to be 100 mm wide, bottom rail 250 mm high, unless otherwise indicated on Drawings.

(b) Stiles and rails are to be from galvanized sheet steel as specified, 1.30 mm thick minimum. Reinforcement for hinge installation is to be minimum 4.00 thick galvanized steel plates. Drilling and tapping for surface applied ironmongery may be done on Project Site.

(c) Louvered Panels: Provide for installation in frames.

   (i) Louvers: 1.3-mm-thick, metallic-coated steel sheet. Fabricate units with stationary, weatherproof shaped blades and U-shaped frames. Space louver blades not more than 38 mm o.c. Assemble units by
welding. Provide removable insect screens on interior side of louver frame, consisting of 1.4-by-1.8-mm mesh formed with 0.28-mm-diameter, galvanized steel wire in rigid, formed-metal frame.

(d) Hardware Reinforcement: Fabricate reinforcing plates from the same material as door to comply with the following:

(i) Hinges and Pivots: 4.00 mm thick by 38 mm wide by 150 mm longer than hinge, secured by not less than 6 spot welds.

(ii) Lock Face, Flush Bolts, Closers, and Concealed Holders: 2.30 mm thick.

(iii) All Other Surface-Mounted Hardware: 1.30 mm thick.

3.5.16 Accessories

1 Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

2 Ceiling Struts: Minimum 6.4 mm thick by 25.4 mm wide steel.

3 Grout Guards: Formed from same material as frames, not less than 0.4 mm thick.

3.5.17 Fabrication

1 Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

2 Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

3 Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

4 Hollow Metal Doors:

(a) Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

(b) Glazed Lites: Factory cut openings in doors.

(c) Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 19 mm beyond edge of door on which astragal is mounted.

5 Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

(a) Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

(b) Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door
frame. Fasten members at crossings and to jambs by butt welding.

(c) Provide countersunk, flat or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

(d) Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

(e) Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

(f) Jamb Anchors: Provide number and spacing of anchors as follows:

(i) Masonry Type: Locate anchors not more than 457 mm from top and bottom of frame. Space anchors not more than 813 mm o.c. and as follows:

1) Two anchors per jamb up to 1524 mm high.
2) Three anchors per jamb from 1524 to 2286 mm high.
3) Four anchors per jamb from 2286 to 3048 mm high.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 610 mm or fraction thereof above 3048 mm high.

(ii) Stud-Wall Type: Locate anchors not more than 457 mm from top and bottom of frame. Space anchors not more than 813 mm o.c. and as follows:

1) Three anchors per jamb up to 1524 mm high.
2) Four anchors per jamb from 1524 to 2286 mm high.
3) Five anchors per jamb from 2286 to 2438 mm high.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 610 mm or fraction thereof above 2438 mm high.
5) Two anchors per head for frames above 1066 mm wide and mounted in metal-stud partitions.

(iii) Compression Type: Not less than two anchors in each jamb.

(iv) Postinstalled Expansion Type: Locate anchors not more than 152 mm from top and bottom of frame. Space anchors not more than 660 mm o.c.

(g) Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

(i) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

(ii) Double-Door Frames: Drill stop in head jamb to receive two door silencers.

(h) Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

(i) Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping as specified in Section 18 "Carpentry, Joinery and Ironmongery."

(i) Locate hardware as indicated, or if not indicated, according to
ANSI/SDI A250.8.

(ii) Reinforce doors and frames to receive nontemplated, mortised and surface mounted door hardware.

(iii) Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

(iv) Coordinate locations of conduit and wiring boxes for electrical connections with Section 26 “Electrical Works”.

(j) Stops and Mouldings: Provide stops and mouldings around glazed lites where indicated. Form corners of stops and mouldings with butted or mitred hairline joints.

(i) Single Glazed Lites: Provide fixed stops and mouldings welded on secure side of hollow metal work.

(ii) Multiple Glazed Lites: Provide fixed and removable stops and mouldings so that each glazed lite is capable of being removed independently.

(iii) Provide fixed frame mouldings on outside of exterior and on secure side of interior doors and frames.

(iv) Provide loose stops and mouldings on inside of hollow metal work.

(v) Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

3.5.18 Finishes

1 Metallic-Coated Steel Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

(a) Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

2 Factory-Applied Finish: Immediately after cleaning and pretreating, apply manufacturer's powder coating finish to comply with requirements as specified in this Section Part 2.

(a) Colour and Gloss: As indicated on Drawings, otherwise as selected by Engineer from manufacturer's full range.

3.5.19 Installation

1 General: Provide doors of sizes, thicknesses, and designs indicated. Install custom steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

2 Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

(a) Set frames accurately in position, plumbed, aligned, and braced securely.
until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

(i) At fire-protection-rated openings, install frames according to NFPA 80.

(ii) Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.

(iii) Install frames with removable glazing stops located on secure side of opening.

(iv) Install door silencers in frames before grouting.

(v) Remove temporary braces necessary for installation only after frames have been properly set and secured.

(vi) Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

(vii) Apply bituminous coating to backs of frames that are filled with mortar and grout.

(b) Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.

(i) Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

(c) Metal-Stud Partitions: Solidly pack mineral-fibre insulation behind frames.

(d) Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.

(e) Concrete Walls: Solidly fill space between frames and concrete with grout. Install grout in lifts and take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

(f) In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

(g) In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

(h) Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.

(i) Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

   (i) Squareness: Plus or minus 1.6 mm, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
(ii) Alignment: Plus or minus 1.6 mm, measured at jambs on a horizontal line parallel to plane of wall.

(iii) Twist: Plus or minus 1.6 mm, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

(iv) Plumbness: Plus or minus 1.6 mm, measured at jambs at floor.

3 Hollow Metal Doors: Fit doors accurately in frames, within clearances specified below. Shim as necessary.

(a) Non-Fire-Rated Standard Steel Doors:

(i) Jambs and Head: 3.0 mm plus or minus 1.6 mm.

(ii) Between Edges of Pairs of Doors: 3.0 mm plus or minus 1.6 mm.

(iii) Between Bottom of Door and Top of Threshold: Maximum 9.5 mm.

(iv) Between Bottom of Door and Top of Finish Floor No Threshold: Maximum 19 mm.

(b) Fire-Rated Doors: Install doors with clearances according to NFPA 80.

(c) Smoke-Control Doors: Install doors according to NFPA 105.

4 Glazing: Comply with installation requirements in Section "Glass and Glazing" and with standard steel door and frame manufacturer's written instructions.

(a) Secure stops with countersunk fla or oval-head machine screws spaced uniformly not more than 230 mm o.c., and not more than 50 mm o.c. from each corner.

3.5.20 Adjusting and Cleaning

1 Final Adjustments: Check and readjust operating hardware items just before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames that are warped, bowed, or otherwise unacceptable.

2 Clean grout and other bonding material off custom steel doors and frames immediately after installation.

3 Finish-Coat Touchup: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

*Amend title of clause 3.7 to be OVERHEAD COILING DOORS as indicated hereafter. Delete its contents entirely and replace with the following:*

3.7 OVERHEAD COILING DOORS

3.7.1 Summary

1 This Section specifies the electric-motor operated Fire Rated overhead coiling service doors.

2 See Sections 21 for electrical service and connections for powered operators and accessories.
3.7.2 Performance Requirements

1 Structural Performance: Provide overhead coiling doors capable of withstanding the effects of gravity and wind loads and stresses without evidencing permanent deformation of door components.

2 Operation-Cycle Requirements: Provide overhead coiling door components and operators capable of operating for not less than 20,000 cycles.

3.7.3 Submittals

1 Product Data: For each type and size of overhead coiling door and accessory.

2 Shop Drawings: Include plans, elevations, sections, details, and attachment to other work.

3 Samples: For each exposed finish.

3.7.4 Quality Assurance

1 Installer Qualifications: Manufacturer’s authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

2 Fire-Rated Door Assemblies: Provide assemblies complying with NFPA 80 that are identical to door and frame assemblies tested for fire-test-response characteristics per UL 10b and UL1784, and that are labeled and listed for fire ratings indicated by UL, FM, ITS/Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.

3 Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a testing agency acceptable to the Engineer that doors comply with all standard construction requirements of tested and labeled fire-rated door assemblies, except for size.

3.7.5 Materials

1 Door Curtains: Interlocking slats in a continuous length for width of door of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door.

- Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper

(a) Aluminum Extrusion Thickness: Not less than 1.30 mm.

- Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel (SS) sheet; complying with ASTM A 653 M, Z275 coating designation.

2 Endlocks and Windlocks: Malleable-iron casings, secured to curtain slats to comply with wind load.

3 Bottom Bar: 2 angles, each not less than 38 by 38 by 3 mm thick to suit type of curtain slats.
Curtain Jamb Guides: Steel angles or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

Hood: Form to act as weatherseal and entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods, and provide fascia for any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sagging.

(a) Steel Door Hoods: Minimum 0.7-mm thick, hot-dip galvanized steel sheet that matches slat steel.

(b) Fabricate hoods for aluminum doors, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; 0.8-mm minimum thickness, complying with ASTM B 209 (ASTM B 209M).

(c) Exterior-Mounted Door: Fabricate hood with sealant-joint bead profile for applying joint sealant.

Integral Frame, Hood, and Fascia: Welded assemblies:

(a) Steel: Minimum 1.6-mm thick, hot-dip galvanized steel sheet that matches door steel.

Integral Sills: Integral part of frame assembly; fabricate of same sheet metal.

Fire-Rated Counter: Provide fire-door manufacturer's high-pressure decorative laminate covered countertop, UL tested and labeled for 1-1/2-hour fire rating for approved use with fire-door assembly.

Weatherseals: Replaceable, adjustable, continuous, compressible weatherstripping gaskets fitted to bottom and top of exterior doors, unless otherwise indicated. At door head, use 3-mm thick, replaceable, continuous sheet secured to inside of hood.

(a) Motor-Operated Doors: Combination bottom weatherseal and sensor edge.

(b) Jamb Seals: Replaceable, adjustable, continuous, flexible, 3-mm thick seals of flexible vinyl, rubber, or neoprene at door jambs for a weathertight installation.

Push/Pull Handles: Galvanized steel lifting handles on each side of door.

(a) Provide pull-down straps or pole hooks for doors more than 2130 mm high.

Slide Bolt: Engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

Locking Device Assembly: Lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bar to engage through slots in tracks.

Power-Operated Doors: Safety interlock switch to disengage power supply when
door is locked.

14 Counterbalancing Mechanism: Adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to door curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

(a) Mounting Brackets: Cast iron or cold-rolled steel plate.

15 Electric Door Operator: Manufacturer’s standard type, size, and capacity for door and operation-cycle requirements specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories. Comply with NFPA 70.

(a) Disconnect Device: Hand-operated for automatically engaging chain and sprocket operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount to be accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

16 Electric Motors: High-starting torque, reversible, continuous-duty, polyphase, Class A insulated, electric motors complying with NEMA MG 1; with overload protection; sized to start, accelerate, and operate door in either direction from any position, at not less than 0.2 m/s and not more than 0.3 m/s, without exceeding nameplate ratings or service factor. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.

(a) Open dripproof-type motor, and controller with NEMA ICS 6, Type 1 enclosure.

(b) Totally enclosed, nonventilated or fan-cooled motor, fitted with plugged drain, and controller with NEMA ICS 6, Type 4 enclosure where indicated.

17 Control Equipment: NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V, ac or dc, with remote, three-button control station.

(a) Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

(b) Exterior units, full-guarded, surface-mounted, standard-duty, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

(c) Obstruction Detection Device: External automatic safety sensor capable of protecting full width of door opening. Activation of sensor immediately stops and reverses downward door travel.

(d) Provide electric operators with ADA-compliant audible alarm and visual indicator lights.

3.7.6 Finishes

1 Steel Door Finish: Powder-Coat Finish: Manufacturer's standard powder-coat finish consisting of primer and topcoat according to coating manufacturer's written instructions for cleaning, pretreatment, application, thermosetting, and
minimum dry film thickness.

- Colour and Gloss: As selected by Engineer from manufacturer's full range.

2 Aluminium Door Finish: PVDF coating, comply with requirements as specified in Section 17 Part 2.

3.7.7 Installation

1 Install coiling doors and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports complying with manufacturer’s written instructions.

2 Lubricate bearings and sliding parts; adjust doors to operate easily, free of warp, twist, or distortion, and with weathertight fit around entire perimeter.

3.10 ALUMINUM GRILLES

3.10.1 SUMMARY

1 Section Includes:

(a) Aluminum Grille.

3.10.2 PERFORMANCE REQUIREMENTS

1 Delegated Design: Design overhead coiling grilles, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2 Operation Cycles: Provide overhead coiling grille components and operators capable of operating for not less than number of cycles indicated for each grille. One operation cycle is complete when a grille is opened from the closed position to the fully open position and returned to the closed position.

3.10.3 SUBMITTALS

1 Product Data: For each type and size of overhead coiling grille and accessory. Include the following:

a) Construction details, material descriptions, dimensions of individual components, profiles for curtain components, and finishes.

2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

3 Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

a) Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b) Wiring Diagrams: For power, signal, and control wiring.

c) Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

4 Qualification Data: For qualified Installer.

5 Maintenance Data: For overhead coiling grilles to include in maintenance manuals.

3.10.4 QUALITY ASSURANCE

1 Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

2 Source Limitations: Obtain overhead coiling grilles from single source from single manufacturer.

   a) Obtain operators and controls from overhead coiling grille manufacturer.

3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3.10.5 MATERIAL

1 Aluminum Grille Curtain: ASTM B 221 alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

3.10.6 ELECTRIC GRILLE OPERATORS

1 General: Electric grille operator assembly of size and capacity recommended and provided by grille manufacturer for grille[ and operation-cycles requirement] specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking grille, and accessories required for proper operation.

   a) Comply with NFPA 70.

   b) Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.

2 Electric Motors: Provide high-starting torque, reversible, continuous-duty, Class A insulated, electric motors complying with NEMA MG 1; with overload protection; sized to start, accelerate, and operate grille in either direction from any position, at not less than 0.2 m/s and not more than 0.3 m/s, without exceeding nameplate ratings or service factor.

   a) Phase: Polyphase.
b) Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.

3 Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

4 Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

5 Limit Switches: Equip each motorized grille with adjustable switches interlocked with motor controls and set to automatically stop grille at fully opened and fully closed positions.

6 Obstruction Detection Device: Equip motorized grille with indicated external automatic safety sensor capable of protecting full width of grille opening. Activation of sensor immediately stops and reverses downward grille travel.

7 Self-Monitoring Type: Designed to interface with grille operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, grille closes only with sustained pressure on close button.

8 Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

9 Self-Monitoring Type: Four-wire configured device designed to interface with grille operator control circuit to detect damage to or disconnection of sensing device.

10 Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."

11 Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

3.10.7 ALUMINUM FINISHES

1 Class II, Clear Anodic Finish: AA-M12C22A31 ( Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

3.10.8 EXECUTION

1. As Manufacture Standards
4. ARCHITECTURAL METAL WORK

4.1 GENERAL

4.1.1 Scope

Add the following new paragraph:

3 Work items covered under this part include, but shall not be limited to, the following:

(a) Ladders
   (i) Steel ladders.

(b) Louvers
   (i) Aluminium louvers
   (ii) Sand trap louver.

(c) Access Details
   (i) Access panels.

(d) Grating

(e) Metal Fittings
   (i) Vanities Supports.

(f) Aluminium Mashrabeya.

4.2 HANDRAILS

4.2.1 General Requirements

Amend paragraph number 1 to read as follows:

1 Height of handrails and balustrades shall as indicated on Drawings.

Replace the table stating metal alloy and reference standards with the next paragraphs:

2 Handrails and balustrade shall be manufactured from material complying with the following:

(a) Stainless steel tubes; pipes, sheets and plates shall be as follows:
   (i) Tubing: ASTM A 554, Grade MT 304 for interior applications and 316L for exterior applications.
   (ii) Pipe: ASTM A 312/A 312M, Grade TP 304 for interior applications and 316L for exterior applications.
   (iii) Castings: ASTM A 743/A 743M, Grade CF 8 or CF 20 for interior installations and 316L for exterior applications.
(iv) Plate and Sheet: ASTM A 666, Type 316L.

(b) Steel tubes; pipes, sheets and plates shall be as follows
   (i) Tubing: ASTM A 500 (cold formed).
   (ii) Bars: Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.
   (iii) Plates, Shapes, and Bars: ASTM A 36/A 36M.
   (iv) Castings: Either grey or malleable iron, unless otherwise indicated.
       1) Grey Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
       2) Malleable Iron: ASTM A 47/A 47M.

(c) Glass and Glazing Materials: Comply with requirements as indicated on Drawings and specified in Section 25 “Glazing”
   (i) Glazing Gaskets: Provide glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass panels in post-supported railings.

Add the following new paragraphs:

4 Performance Requirements:
   (a) General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
       (i) Aluminium: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
       (ii) Stainless Steel: 60 percent of minimum yield strength.
       (iii) Steel: 72 percent of minimum yield strength.
       (iv) Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminium Curtain Wall Series No.12, "Structural Properties of Glass."

   (b) Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated
       (i) Handrails:
           1) Uniform load of 0.73 kN/m applied in any direction.
           2) Concentrated load of 0.89 kN applied in any direction.
           3) Uniform and concentrated loads need not be assumed to act concurrently.
       (ii) Top Rails of Guards:
           1) Uniform load of 0.73 kN/m applied horizontally and concurrently with 1.46 kN/m applied vertically downward.
2) Concentrated load of 0.89 kN applied in any direction.

3) Uniform and concentrated loads need not be assumed to act concurrently.

(iii) Infill of Guards:
1) Concentrated load of 0.22 kN applied horizontally on an area of 0.093 sq. m.

2) Uniform load of 1.2 kN/sq. m applied horizontally.

3) Infill load and other loads need not be assumed to act concurrently.

(iv) Glass-Supported Railings: Support each section of top rail by a minimum of three glass panels or by other means so top rail will remain in place if any one panel fails.

(c) Thermal Movements: Provide exterior handrails and railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

(i) Temperature Change (Range): 35 deg. C, ambient; 70 deg. C, material surfaces.

(d) Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials

5 Fabrication

(a) General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

(b) Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

(c) Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1 mm, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

(d) Form work true to line and level with accurate angles and surfaces.

(e) Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

(f) Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

(g) Connections: Fabricate railings with welded connections, unless otherwise indicated.
(h) Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   (i) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   (ii) Obtain fusion without undercut or overlap.
   (iii) Remove flux immediately.
   (iv) At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

(i) Welded Connections for Aluminium Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer’s standard system of sleeve and socket fittings.

(j) Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 6 mm or less.

(k) Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.
   (i) At brackets and fittings fastened to plaster or gypsum board partitions, provide fillers made from crush-resistant material, or other means to transfer wall loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

(l) Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

(m) For railing posts set in concrete, provide steel sleeves not less than 150 mm long with inside dimensions not less than 13 mm greater than outside dimensions of post, with steel plate forming bottom closure.

(n) For removable railing posts, fabricate slip-fit sockets from steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
   (i) Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

(o) Glazing Panel Fabrication: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

6 Anchors: Provide torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six
times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

7 Corrosion Protection: Coat concealed surfaces of aluminium that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

8 Submittals for handrails and balustrades shall also include engineering calculations, shop drawings including details for anchorages and fixation system, samples of all components, product test reports indicating handrails and railings comply with ASTM E 985, based on comprehensive testing of current products. Before the start of any site installation, provide a complete prototype balustrade to an apartment balcony in a location to be directed by the Engineer.

9 Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 50 mm beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 150 mm of post.

10 Finishes, General

(a) Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

(b) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

(c) Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

(d) Provide exposed fasteners with finish matching appearance, including colour and texture, of railings.

11 Stainless-Steel Finishes

(a) Remove tool and die marks and stretch lines or blend into finish.

(b) Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

(c) Dull Satin Finish: No. 6.

12 Aluminium Finishes:

(a) Comply with requirements as specified in this Section Part 2

13 Steel Finishes:

(a) Internal Applications: Epoxy paint system, comply with requirements as
specified in Section 26

(b) External Applications: Polyurethane top coat over epoxy paint system, comply with requirements as specified in Section 26.

**Add the following new sub-clauses**

**4.2.4 Submittals**

1. **Product Data:** For mechanically connected railings, grout, anchoring cement, and paint products.

2. **Shop Drawings:** Include plans, elevations, sections, details, and attachments to other work.

3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. **Samples:** For each exposed finish required.

5. **Product Test Reports.**

**Add the following new clauses and sub-clauses:**

**4.5 LADDERS**

**4.5.1 Steel Ladders**

1 **General:** Fabricate ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.

   (a) Comply with ANSI A14.3, unless otherwise indicated.

   (b) For elevator pit ladders, comply with ASME A17.1.

2 **Siderails:** Continuous, 12-by-64-mm steel flat bars, with eased edges, spaced 460 mm apart.

3 **Bar Rungs:** 20-mm-diameter steel bars, spaced 300 mm o.c.

4 **Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.**

5 **Support each ladder at top and bottom and not more than 1500 mm o.c. with welded or bolted steel brackets.**

   (a) Size brackets to support design dead and live loads indicated and to hold centreline of ladder rungs clear of the wall surface by not less than 180 mm.

   (b) Extend side rails 1.1 m above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.
6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminium-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminium-oxide grout.

7. Galvanize ladders, including brackets and fasteners, in the following locations:
   (a) Exterior.
   (b) Interior, where indicated.

8. Finish is to be field-applied polyurethane-based coating system of colour selected by the Engineer. Comply with requirements of Section 26, “Painting and Decorating”.

4.6 LOUVERS

4.6.1 Materials

1. Aluminium: BS EN 485, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish
   (a) Alloy and temper are to be as recommended by the manufacture to suit the application and the specified finish
   (b) Finish: PVDF as specified in this Section Part 2.


3. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

4. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.


4.6.2 Performance Requirements

1. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.

2. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky
heat loss.

(a) Temperature Change (Range): 35 deg. C, ambient ; 70 deg. C, material surfaces.

4.6.3 Fixed, Extruded-Aluminium Louvers

1 Horizontal Louvers: Comply with the following:

(a) Material: Extruded Aluminium
(b) Louver Depth: 100 mm, unless otherwise indicated.
(c) Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 2 mm.
(d) Mullion Type: Exposed, unless otherwise indicated.
(e) Performance Requirements: Louvre system shall achieve Class D1 when tested at all velocities to EN 13030: 2001, with a minimum performance coefficient of 0.27 (inlet).

4.6.4 Louver Screens

1 General: Provide louvers with screens at locations indicated.

2 General: Provide each exterior louver with louver screens complying with the following requirements:

(a) Screen Location for Fixed Louvers: Interior face.
(b) Screening Type: Insect screening, unless otherwise indicated.

3 Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 150 mm from each corner and at 300 mm o.c.

4 Louver Screen Frames: Fabricate screen frames with mitred corners to louver sizes indicated and to comply with the following requirements:

(a) Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminium screen frames at corners with clips.
(b) Finish same finish as louver frames to which louver screens are attached.
(c) Type: Rewirable frames with a driven spline or insert for securing screen mesh.

5 Louver Screening for Aluminium Louvers: As follows:

(a) Insect Screening: Aluminium, 1.4-mm-square mesh, 0.3 mm wire.

4.6.5 Sand Trap Louvers

1 Shall be surface mounted louvers fabricated from aluminium with PVDF Coating for topcoat of the system and of same colour as used for aluminium windows and
entrances in the project. Thickness of blades shall not be less than 0.70 mm.

2 Sand trap louvers shall be surface-mounted of vertical, U-shaped channel blades, two-row, site assembled construction in an interlocking pattern with blades spaced on centres according to the wind loading.

3 Provide flashing for head, sill and jamb of same material and finish as louvers.

4 Louver Free Area: Not less than 32%.

5 Performance requirements: Separate efficiency on simulated desert sand dust (from 1 micron to 89 microns) is to be not less than 85%.

6 Louver Screen: Provide screen at each exterior louver and where indicated.
   (a) Screen Location for Fixed Louvers: Interior face.
   (b) Screening Type: Bird screening.
   (c) Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 150 mm from each corner and at 300 mm o.c.
   (d) Louver Screen Frames: Fabricate with mitred corners to louver sizes indicated.
   (e) Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminium screen frames at corners with clips.
   (f) Finish same finish as louver frames to which louver screens are attached.
   (g) Type: Rewirable frames with a driven spline or insert for securing screen mesh.

4.6.6 Motorized Louver

1 Louver: Comply with specifications of fixed extruded aluminium louver.

2 Operation

4.7 ACCESS DETAILS

4.7.1 Access Doors

1 Recessed Panels for Ceramic tiles: Units consisting of frame with expansion casing bead, door, and hardware and complying with the following requirements:
   (a) Frame: Zinc-coated steel sections and shapes.
   (b) Plaster casing Bead: 0.76 mm zinc coated steel casing bead with flange formed out of expanded metal lath.
   (c) Panel: 2 mm zinc coated steel sheet.
   (d) Finish: matching adjacent walls as indicated on Drawings
   (e) Hardware: Nickel-plated steel hinges, exposed type and self-latching bolt operated with knurled knob.
4.7.3 Access Panels

(a) Galvanized Steel, shaft access panel

4.8 GRATING

1 Trench Cover Grating: BS EN 124, Class B215, cast iron grating, heavy duty type. Furnish complete with galvanized steel frame of welded slotted anchors for embedding into adjoining concrete and with 5 mm thick continuous neoprene strips.

4.8 METAL FITTINGS

4.8.1 Vanity Supports

1 Vanity supports are to be fabricated from hot-rolled, normal-mild steel sections in welded construction to details indicated on Drawings and approved shop drawings. Hot-dip galvanize after fabrication with zinc coating intensity not less than 300 gm/m². Finish is to be field-applied alkyd paint as specified in Section “Painting and Decorating”. Colour is to be as directed by the Engineer.

4.8.3 Stainless Steel Strip Divider

1 Fabricate from alloy 304 stainless steel components.
2 Furnish stainless steel strips in length as practical.
3 Comply with details indicated on Drawings and approved Shop Drawings.

4.9 ALUMINUM MASHARABEYA

4.9.1 General

1 Custom designed and fabricated decorative-quality aluminium masharabeya.
2 Aluminium Alloy and temper as recommended by manufacture, composed of extruded aluminium frame of 2.0 mm and aluminium sheet of 2.0 mm, comply with details and configuration as indicated on Drawings and approved shop drawings.
3 Aluminium Finish: PVDF coating, comply with requirements as specified in this Section Part 2. Colour and Gloss shall be selected by the Engineer.
4 Finish mashrabeya after assembly.
5 Corrosion Protection: Coat concealed surfaces of aluminium that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
7 DECORATIVE METALS

7.1 GENERAL

1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

7.2 Interior Stainless Steel Wall Covering

Snap-Together Type: Form wall covers to shapes indicated from metal of type and thickness indicated below.

1. General:
   (a) Form wall covers to shapes indicated from material of type and thickness indicated below.
   (b) Return vertical edges and bend to form hook that will engage continuous mounting clips.
   (c) Form returns at vertical joints to provide soft vee joints.
   (d) Fabricate wall covers with horizontal butt joints, tightly fitted and backed with a sleeve for field splicing with adhesive.
   (e) Apply a coating of heavy-build, sound-deadening mastic to backs of wall covers.
   (f) Wall covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.

2. Stainless Steel Sheet:
   (a) Minimum Thickness: 1.2 mm.
   (b) Backing: Reinforce with concealed stiffeners, solid backing materials or both.

7.2 Decorative Steel Mashrabiya

1. Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
3. Plates, Shapes, and Bars: ASTM A 36/A 36M.
4. Castings: Either gray or malleable iron, unless otherwise indicated.
   (a) Gray Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.
   (b) Malleable Iron: ASTM A 47/A 47M.
5. Steel Sheet, Cold Rolled: ASTM A 1008, either commercial steel, Type B, or structural steel, Grade 25 (Grade 170), exposed.
7.3 FASTENERS

1. Fastener Materials: Unless otherwise indicated, provide the following:
   (a) Uncoated Steel Items: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed, Type 304 stainless-steel fasteners where exposed.

2. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.

3. Provide concealed fasteners for interconnecting components and for attaching ornamental metal items to other work, unless exposed fasteners are unavoidable.
   (a) Provide tamper-resistant flat-head machine screws for exposed fasteners, unless otherwise indicated.

4. Anchors: Provide cast-in-place torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

7.4 MISCELLANEOUS MATERIALS

1. Welding Rods and Bare Electrodes: Do not weld steel on site.

2. Adhesives: Adhesives for Ornamental formed metal fabrications are to be:
   (a) Proprietary types recommended for high quality decorative works.
   (b) Produced for the purpose.
   (c) Compatible with the metal being adhered and the substrate adhered to.
   (d) Types that cure and set without shrinkage.
   (e) On vertical surfaces, shall be non-sag.
   (f) Setting shall be as quick as suitable for the job erected.
   (g) Types that develop high bond strength between the metal and substrate so as delamination of metal or layers shall not occur for a minimum of 20 years.
   (h) One-part products to maximum possible extent.
   (i) Can be cut after initial curing.
   (j) Epoxy based as long as available for the purpose.
   (k) Compatible with silicones and caulking materials that may come in contact with them.
   (l) Cleaned with cleaning materials that do not affect surface finish of adhered metal or substrate.

7.5 FABRICATION, GENERAL

1. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

2. Coordinate dimensions and attachment methods of formed-metal fabrications with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned, unless otherwise indicated.

3. Form ornamental metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arises.

4. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

5. Form simple and compound curves in bars and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

6. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1 mm, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

7. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

8. Provide weep holes where water may accumulate.

9. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items, unless otherwise indicated.

10. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

11. Comply with AWS for recommended practices in shop welding.

12. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

13. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness specified for stretcher-leveled sheet metal and sufficient strength for indicated use.

(a) Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
14. Build in straps, plates, and brackets as needed to support and anchor fabricated items to adjoining construction. Reinforce formed-metal units as needed to attach and support other construction.

15. Provide support framing, mounting and attachment clips, splice sleeves, fasteners, and accessories needed to install formed-metal fabrications.

7.6 STAINLESS-STEEL FINISHES

1. Remove or blend tool and die marks and stretch lines into finish.

2. Unless otherwise indicated, grind and polish surfaces to produce uniform finish indicated, free of cross scratches.

3. Directional Satin Finish: No. 4 finish.

4. Dull Satin Finish: No. 6 finish.

5. Reflective, Directional Polish: No. 7 finish.


7. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

7.7 STEEL FINISHES

1. Galvanizing for Concealed Mounting: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123.

   (a) Hot-dip galvanize iron and steel hardware indicated to be galvanized to comply with ASTM A 153/A 153M.

   (b) Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.

2. Powder Coating Finish: Apply polyester powder coating electrostatically, lead free, comply with EN 12206, and Qualicoat Class 1, with a cured-film thickness not less than 60 microns.

7.8 INSTALLATION, GENERAL

1. Provide anchorage devices and fasteners where needed to secure ornamental metal to in-place construction.

2. Perform cutting, drilling, and fitting required to install ornamental metal. Set products accurately in location, alignment, and elevation; measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

3. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, and grinding are required for proper shop fitting and jointing of ornamental metal, restore finishes to eliminate evidence of such corrective work.
4. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

5. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.

6. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.

   (a) Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

7.9 PROTECTION

1. Protect finishes of ornamental metal from damage during construction period with temporary protective coverings approved by ornamental metal fabricator. Remove protective covering at time of Substantial Completion.

2. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.
SECTION 18

CARPENTRY, JOINERY AND IRONMONGERY
1. GENERAL

1.1 INTRODUCTION

1.1.2 References

Replace reference to BS 729 to be as follows:

BS EN ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

Replace reference to BS 6459 to be as follows:

BS EN 1154 Building hardware. Controlled door closing devices. Requirements and test methods

Replace reference to BS 6566 to be as follows:

BS EN 635 Plywood

Replace reference to BS 7352 to be as follows:

BS EN 1935 Building hardware. Single-axis hinges. Requirements and test methods

Add the following new reference:

BS EN 636 Plywood. Specifications
BS EN 942 Timber for Joinery. General Classification of Timber Quality
BS EN 622 Fibreboard. Specifications

1.2 TIMBER TYPES

Amend paragraph number 1 to be read as follows:

1 Softwood is to comply with relevant provisions of BS EN 942, class J30 generally and Class J2 for special work.

Amend first sentence of paragraph number 2 to read as follows:

“Hardwood is to comply with relevant provisions of BS EN 942.”

Add the following new paragraph no 6:

6 Fibreboard is to comply with relevant provisions of BS EN 622.

Add the following new clause:

1.6 SUBMITTALS FOR ENGINEER’S APPROVAL

1 Submit co-ordination, fabrication and installation drawings and other information
showing details of each item of woodwork as the Engineer may require, including elevations, large-scale sections and proposed methods of fixing.

2 Submit manufacturers’ technical data for all materials, products included in the works. Include detailed description of materials and methods used in wood treatment.

3 Submit samples of each type of wood, veneer, finish, accessory, fixing, fastener and each item of woodwork. Obtain approval of appearance and other relevant characteristics before proceeding with manufacture or delivery.

4 After completion of woodwork details prepare one mock-up of each item of purpose-made woodwork and obtain approval of materials, finish, method of construction and appearance before proceeding with manufacture of remaining quantity. Approved mock-ups will become part of the quantity required for the project.

5 Submit samples of each item of ironmongery and other proprietary items.
2 WOOD TREATMENT

2.2 PRESERVATIVE TREATMENT

2.2.1 General Application

Add the Following new paragraphs:

4 Organic solvent preservative treatment, moisture content of timber at the time of treatment shall be as specified for the component at time of delivery. Timber surface shall be dry before use. Application shall be with double vacuum/low pressure.

5 Water based micro emulsion preservative treatment; moisture content of timber at the time of treatment shall be as specified for the component at time of delivery. Timber surface shall be dry before use. Application shall be with double vacuum/low pressure.

6 Creosote preservation treatment, moisture content of timber at time of treatment shall be not more than 28%. Allow timber to dry before use. Application shall be with double vacuum /low pressure.

7 Born compound preservation treatment, moisture content of timber at time of treatment shall be not more than 28%. Allow timber to dry before use. Application shall be with double vacuum /low pressure.

8 Fire retardant treatment: Moisture content at time of treatment shall be as specified for the timber at time of fixing. After treatment, timber shall be dried slowly at temperatures not exceeding 65°C to minimize degradation and distortion. Application shall be with vacuum/pressure.

9 Leach resistant flame retardant treatment, moisture content at time of treatment shall be as specified for the timber at time of fixing. Application shall be with vacuum/pressure.

10 Re-treat all treated wood which is sawn along the length, ploughed, thickness, planed or otherwise extensively processed. Treat wood surfaces exposed by minor cutting and drilling with two flood coats of solution recommended for the purpose by the treatment solution manufacturer.
4 ARCHITECTURAL TIMBER

Add the Following new paragraphs:

4.4 Wood Panelling:

4.4.1 General

1. Are to be proprietary acoustical wall panels, complying with the following requirements:

   (a) Grade: Premium
   (b) Panel Core Construction: plywood/MDF.
   (c) Thickness: 18 mm, unless otherwise indicated on Drawings.
   (d) Face Panel: plastic laminate, as indicated on Drawings. Panels are to be perforated and solid panels as indicated.
   (e) Shape and arrangement of perforations are to be to the selection of the Engineer.
   (f) Backing Material: Sound absorbent fabric layer, factory laminated at back of perforated panels. Provide fabric layer, sized to fit back surface of panels, and consisting of nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing per ASTM E 84. Color of fabric is to be selected by the Engineer from manufacturer's range.
   (g) Mounting: Mechanically-mounted with two-part panel clips, one part attached at panel back and the second to wall substrate, fabricated from galvanised sheet steel.
   (h) Dimensions: As indicated on Drawings
   (i) Edge detail: Square
   (j) Finish: Factory-applied stained polyurethane varnish as specified.
   (k) Solid Panels: Are to comply with requirements specified in this Section except for perforations and backing materials. Use solid panels produced by same manufacturer of perforated panels for veneer matching.

4.4.4 INSTALLATION

1. Grade: Install paneling to comply with requirements for same grade specified in Part 2 for fabrication of type of paneling involved.

2. Install paneling level, plumb, true, and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 3 mm in 2400 mm. Install with no more than 1.6 mm in 2400-mm vertical cup or bow and 3 mm in 2400-mm horizontal variation from a true plane.

3. Scribe and cut paneling to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.
4. Anchor paneling to supporting substrate with concealed panel-hanger clips. Do not use face fastening unless covered by trim.

5. Complete the finishing work specified in this Section to extent not completed at shop or before installation of paneling. Fill nail holes with matching filler where exposed. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats were applied in shop.

4.9 Pantry Cupboard

1. Base counters and upper cabinets units shall be pre-fabricated units constructed to dimensions and details indicated on Drawings.

   (a) Colors, Patterns, and Finishes: As selected by Engineer from plastic-laminate manufacturer's full range of solid colors.


4. Construct units from the following materials so as to have all exposed or semi-exposed surfaces of plastic laminate finish:
   (a) Plywood with postformed plastic laminate finish.
   (b) Thickness: as indicated on drawings.
   (c) Color and pattern to the selection of the Engineer. Units are to be assembled in manufacturer's standard system to provide neat and robust construction.
   (d) All base carcasses stand on 150 mm adjustable legs. Legs to be made of PVC plinth clip to the leg.
   (e) Provide metal pre-slotted shelf holders of baked enamel finish complete with removable brackets for shelf supporting. Color is to be to the selection of the Engineer.

5. Provide manufacturer’s standard hardware including hinges, latches and knobs of finish to the selection of the Engineer. All hardware shall be manufactured from stainless steel, alloy 304, of satin finish.
   (a) Hinges are concealed type, opening to 170 degree auto spring loaded closing mechanism for gentle self-closing action and adjustable of the door in two directions.
5. JOINERY

5.1 GENERAL REQUIREMENTS

5.1.1 Scope

*Add the following at the end of paragraph no.2:*

Section 17  Metal Work
Section 25  Glass and Glazing

5.1.2 References

*Amend reference to BS 1186 to read as follows*

BS 1186  Quality of timber and workmanship in joinery
          Part 2: Specification for Workmanship

*Add the following new references*

BS EN 312  Particleboards. Specifications.
BS EN 942  Timber for Joinery. General Classification of Timber Quality

5.2 WORKMANSHIP

5.2.1 Joinery Workmanship

*Amend paragraphs number 1 to be read as follows:*

1  Timber used for joinery work is to be finished to sizes indicated in the project documentation and to BS EN 942.

*Add the following new paragraphs:*

8  Site dimensions must be taken and recorded on shop drawings before starting to make all items under this section.

9  Form sections out of the solid unless otherwise specified; carefully machine wood to accurate lengths and profiles free from twist and bowing; after machining surfaces are to be smooth and free from machining defects.

10  Assemble with tight, close fitting joints to produce rigid components free from distortion and within specified tolerances.

11  Nail heads that will be visible in completed shall be punched below surfaces of timber.

12  Screw heads in timber that will be visible in completed work shall be countersunk not less than 2 mm below the timber surface. Unless otherwise specified, screws of 8 gages or more shall have clearance holes and screws into hardwood shall
have pilot holes.

13 Methods of fixing and fastenings to be to manufacturer’s recommendation. Straight runs shall be formed in single lengths to the maximum possible extent. Location and method of forming running joints to be approved by the Engineer where not detailed. All joints at angles must be mitred unless specified otherwise. Moisture content of timber and wood based boards to be maintained during storage and installation within the range specified for the component.

14 No splicing is permitted in facing material without written approval form the Engineer according to very limited restriction as the facing area.

15 Make joinery to the sizes shown on the Drawings subject to the following tolerances:

- Straightness in each 8 m (not cumulative): ± 5 mm
- Length up to 2 m: ± 3 mm
- Squareness of frames/linings: 1 mm in 500 mm
- Clearance between door leaf and frames: 2 mm (+1 mm, -0.5 mm).

5.3 TIMBER DOOR TYPES

5.3.1 Flush Doors

In paragraph number 1, sub-paragraph (a), amend minimum thickness of internal wood doors to 45 mm.

In paragraph number 3, amend minimum percentage of timber in semi-solid core doors to 65 and add the following sentence at the end of the paragraph:

“Each horizontal cross rail shall be in one piece. Fixed to the door stile throughout door leaf height by mortise-and-tenon joints, manufactured from preservative treated Douglas firwood.

In paragraph number 4, amend plywood skin to be 6 mm.

In paragraph number 6, add the following at the end:

“Hardwood lipping shall be fixed at full length of internal door leaf frame perimeter at continuous spine joint. Lipping shall extend outside the thickness of the door core so as plywood veneer skins are adhered to core within internal edges of lipping.”

Add the following new paragraphs:

9 Joints between stiles and rails for door leaf internal frame and between cross rails and stiles shall be mortise and groove joints glued with jigs.

10 Flush wood doors that will be hung to steel frames are to be factory matched with sample of steel frames.

11 Minimum width of wood sections for internal doorframe shall be 140 mm.
12 **Plastic-Laminate-Faced Doors:** Comply with the following requirements:

(a) Grade: Premium.

(b) Laminate Faces: High-pressure decorative laminates complying with NEMA LD 3, Grade HGS.

(c) Colors, Patterns, and Finishes: Provide samples to Engineer for approval based on Drawings, Schedules and Specifications.

(d) Stiles: Plastic-laminate matching faces, applied before faces.

13 Skins or facing material shall be glued to core and frame. No nail-fixing exposed or concealed, for facing material shall be permissible. The assembly shall be glued under pressure with waterproof casein glue and be thoroughly dried and seasoned.

14 Factory machine doors for hardware that is not surface applied. Locate hardware as indicated on approved shop drawings. Comply with final hardware schedules, doorframe shop drawings, and hardware templates. Coordinate measurements of hardware mortises in steel frames to verify dimensions and alignment before factory machining.

15 Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required. Trim light openings with mouldings of material and profile indicated. Factory installed louvers in prepared openings.

16 Shop prime exposed portions of doors for opaque paint finish with one coat of wood primer specified in Section "Painting and Decorating."

17 Blocking: Provide wood blocking in doors as needed to as follows:

(a) 125-mm top-rail blocking, in doors indicated to have closers.

(b) 125-mm bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armour plates.

(c) 125-mm midrail blocking, in doors indicated to have exit devices.

(d) As necessary to eliminate need for through-bolting hardware.

18 **Veneer-Faced Solid Core Doors:**

(a) Core: Particleboard.

(b) Construction: Five or seven plies with stiles and rails bonded to core, and then entire unit abrasive planed before veneering.

19 Appearance Class: J2, according to BS EN 942

20 Quality Standard: Comply with requirements of BS 4787-1.

*Add the following new paragraphs to 5.3.2*

7 Construction and core specified above for type of face indicated, unless otherwise higher construction is recommended by manufacturer to satisfy fire
resistance rating indicated.

8 Edge Construction: Provide edge construction with intumescent seals concealed by outer stile matching face veneer, and laminated backing at hinge stiles for improved screw-holding capability and split resistance.

9 Pairs: Unless otherwise indicated in Hardware Schedule, provide fire-rated pairs with fire-retardant stiles matching face veneer that are labelled and listed for kinds of applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals.

Add the following new paragraphs

5.3.5 Semi Solid Cores Doors

1 Stiles and Rails: Hardwood for painting or approved softwood lipped with 15 mm hardwood for painting in glued continuous tongue and groove joints. Overall depth of stiles and rails is to be 100 mm except lock stile to be 140 mm.

2 Cross Rails: softwood rails glue tenoned to tiles. Solid area of wood rails shall be two thirds of core area.

3 Assembly abrasive planed in the machine.

4 Faces: 4 mm thick Plywood unless otherwise indicated on drawings fixed with glue and pressure to receive wood veneer or opaque paint finish.

5 Thickness of lipping of stiles is to exceed thickness of semi-solid core to retain outer edges of door faces.

5.3.6 Acoustic Rated Wood Doors

1 Provide core indicated or special construction core as required to meet STC rating indicated on Drawings. All STC ratings must be tested as operable.

1 Provide gasketing and door shoe and mortise door bottom as required to meet manufacturers tested acoustic rating.

(a) Hollow metal frames shall be fully grouted or packed with mineral wool where acoustic rated wood doors are installed.

5.3.7 Louvers

1 Metal Louvers: As follows:

(a) Blade Type: Vision proof, inverted Y, unless otherwise indicated.

(b) Metal and Finish: Extruded aluminium with polyester powder coating finish, 60 micron minimum thickness to match door colour.

2 Metal Frames for Light Openings in Fire Doors: Manufacturer's standard frame formed of 1.2-mm- thick, cold-rolled steel sheet; factory primed and approved for use in doors of fire rating indicated.

3 Dimensions and locations of installation of louvers and light frames are to be as
indicated on Drawings.

5.5 ARCHITRAVES, QUADRANTS, AND BEADS

5.5.1 General Requirements

Add the Following new paragraphs:

4 Furnish architraves, quadrants and beads in integral pieces. No splicing shall be acceptable.

5.6 TIMBER SKIRTINGS

5.6.1 General Requirements

Amend paragraph number 1 to be read as follows:

1 Skirtings are to be fixed with galvanized wood screws and hard nylon wall plugs of suitable diameter at maximum intervals of 600 mm on centres. Countersink heads screws in wood and overfill with approved wood filler of matching colour.

Add the following new paragraph:

3 Furnish timber skirtings in lengths as long as practical. Minimize joints to the maximum possible extent.

5.7 WOOD SKIRTING

1 Are to be constructed from oak hardwood veneer, species to be as indicated on drawings and cut sheet and selected by Engineer from manufacturer full range.

(a) Fabricate to dimensions and details indicated.

(b) Furnish in length as long as practice.

(c) Corners are to be mitered at 45 degrees.

(d) Finish: matt.

Add the following new Clause:

5.8 ADJUSTING AND PROTECTING

1 Rehang or replace doors that do not swing or operate freely.

2 Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Taking Over by the Employer.
7. IRONMONGERY

7.1 GENERAL

7.1.1 Summary

1 This Part includes the following:
   (a) Commercial door hardware for the following:
       (i) Swinging doors.
       (ii) Other doors to the extent indicated.
   (b) Cylinders for doors specified in other Sections.

2 Related Sections include the following:
   (a) Section 17 Part "Steel Doors and Windows".
   (b) Section 17 Part "Access Doors and Frames" for access door hardware.
   (c) Section 17 Part "Overhead Coiling Doors" for door hardware provided as part of overhead door assemblies.
   (d) Section 17 Part "Aluminium-Framed Entrances and Storefronts" for entrance door hardware.
   (e) Section 18 Part "Flush Wood Doors" for astragals and integral intumescent seals provided as part of fire-rated labelled assemblies.
   (f) Section 21 Part 38 “Access Control System” for electromagnetic door lock.
   (g) Section 21 for connections to electrical power system and for low-voltage wiring work.
   (h) Section 32 "Radiation Protection" for lead-lined astragals provided as part of fire-rated labelled assemblies.

7.1.3 Submittals

1 Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

2 Shop Drawings: Details of electrified door hardware, indicating the following:
   (a) Wiring Diagrams: Power, signal, and control wiring. Include the following:
       (i) System schematic.
       (ii) Point-to-point wiring diagram.
       (iii) Riser diagram.
       (iv) Elevation of each door.
   (b) Detail interface between electrified door hardware and fire alarm, access
control, security, and building control system.

(c) Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

3 Samples for Initial Selection: For each finish, colour, and texture required for each type of door hardware indicated.

4 Samples for Verification: Submit minimum 51-by-102-mm plate Samples of each type of finish required, except primed finish.

5 Samples for Verification: For exposed door hardware of each type, in specified finish, full size. Tag with full description for coordination with the door hardware sets. Submit Samples before, or concurrent with, submission of the final door hardware sets.

6 Product Certificates: For electrified door hardware, signed by product manufacturer.

   (a) Certify that door hardware approved for use on types and sizes of labelled fire doors complies with listed fire door assemblies.

7 Qualification Data: For Installer and Architectural Hardware Consultant.

8 Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches, delayed-egress locks and closers.

9 Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

10 Warranty.

11 Other Action Submittals:

   (a) Door Hardware Sets: Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

   (b) Keying Schedule: Prepared by or under the supervision of [Installer] [Architectural Hardware Consultant], detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

7.1.4 Quality Assurance

1 Electrified Door Hardware: Prepare data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project

2 Installer Qualifications: An experienced installer who has completed door
hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

3 Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

(a) Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

4 Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labelled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

(a) Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 1016 mm or less above the sill.

5 Electrified Door Hardware: Listed and labelled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

6 Keying Conference: Conduct conference at Project site to review door hardware keying system including, but not limited to, the following:

(a) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.

(b) Preliminary key system schematic diagram.

(c) Requirements for key control system.

(d) Address for delivery of keys.

7 Pre-installation Conference: Conduct conference at Project site to review methods and procedures related to electrified door hardware including, but not limited to, the following:

(a) Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.

(b) Review sequence of operation for each type of electrified door hardware.

(c) Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.

(d) Review required testing, inspecting, and certifying procedures.

7.1.5 Delivery, Storage, and Handling

1 Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
2 Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

3 Deliver keys to Owner by registered mail or overnight package service.

### 7.1.6 Coordination

1 Coordinate layout and installation of recessed pivots and closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements.

2 Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

3 Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to fire alarm system and detection devices, access control system, security system, and building control system.

### 7.1.7 Warranty

1 Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.

   (a) Failures include, but are not limited to, the following:

      (i) Structural failures including excessive deflection, cracking, or breakage.

      (ii) Faulty operation of operators and door hardware.

      (iii) Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

   (b) Warranty Period: Three years from date of Substantial Completion, except as follows:

      (i) Electromagnetic, and Delayed-Egress Locks: Five years from date of Substantial Completion.

      (ii) Exit Devices: Two years from date of Substantial Completion.

      (iii) Manual Closers: 10 years from date of Substantial Completion.

      (iv) Concealed Floor Closers: 10 years from date of Substantial Completion.

### 7.1.8 Maintenance Service

1 Maintenance Tools and Instructions: Furnish a complete set of specialized tools
and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

2 Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

7.1.9 Extra Materials

1 Furnish full-size units of door hardware described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

(a) Door Hardware: 3%.

7.2 PRODUCTSScheduled Door Hardware

(a) Door Hardware Sets: Provide quantity, item, size, finish or colour indicated.

(b) Sequence of Operation: Provide electrified door hardware function as required, sequence of operation, and interface with other building control systems indicated.

(c) Base Metal for all hardware and door furniture units including hinges, closers covers, face, plates trims ....) shall be stainless steel 316.

7.2.4 Hinges, General

1 Quantity: Provide the following, unless otherwise indicated:

(a) Two Hinges: For doors with heights up to 1524 mm.

(b) Three Hinges: For doors with heights 1549 to 2286 mm.

(c) Four Hinges: For doors with heights 2311 to 3048 mm.

(d) For doors with heights more than 3048 mm, provide 4 hinges, plus 1 hinge for every 750 mm of door height greater than 3048 mm.

2 Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

3 Hinge Weight: Unless otherwise indicated, provide the following:

(a) Entrance Doors: Heavy-weight hinges.

(b) Doors with Closers: Antifriction-bearing hinges.

(c) Interior Doors: Standard-weight hinges.

4 Hinge Base Metal: Unless otherwise indicated, provide the following:
(a) Exterior Hinges: Stainless steel, with stainless-steel pin.
(b) Interior Hinges: Stainless steel, with stainless-steel pin.
(c) Hinges for Fire-Rated Assemblies: Stainless steel, with stainless-steel pin.

5 Hinge Options: Where indicated in door hardware sets or on Drawings:
(a) Hospital Tips: Slope ends of hinge barrel.
(b) Decorator Tips: Ball.
(c) Safety Stud: Designed for stud in one leaf to engage hole in opposing leaf.
(d) Maximum Security Pin: Fix pin in hinge barrel after it is inserted.
(e) Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.
(f) Corners: Square.

6 Fasteners: Comply with the following:
(g) Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
(h) Wood Screws: For wood doors and frames.
(i) Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
(j) Screws: Phillips flat-head. Finish screw heads to match surface of hinges.

7.2.5 Hinges
1 Butts and Hinges: Listed under Category A in BHMA's "Certified Product Directory."

2 Template Hinge Dimensions: BHMA A156.7.

3 Antifriction-Bearing, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings; button tips; nonrising removable pins; and base metal as follows:
   (a) Base Metal: Stainless steel.

4 Antifriction-Bearing, Swing-Clear, Full-Mortise (Butt) Hinges: BHMA A156.1, heavy weight; Grade 1, with 4 ball bearings; button tips; nonrising removable pins; reversible; with 2.4-mm swaging; wrought, forged, or cast steel, or malleable iron.

5 Antifriction-Bearing, Swing-Clear, Heavy-Weight, Half-Mortise Hinges: BHMA A156.1, Grade 1, button tips, nonrising removable pins, reversible, equipped with 4 ball bearings; wrought, forged, or cast steel, or malleable iron.

6 Antifriction-Bearing, Swing-Clear, Heavy-Weight, Full-Surface Hinges:
BHMA A156.1, Grade 1, button tips, nonrising removable pins, reversible, equipped with 4 ball bearings; wrought, forged, or cast steel, or malleable iron.

7.2.6 Locks and Latches, General

1 Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." and ANSI A117.1.

(a) Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 22 N.

2 Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 67 N to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

3 Electrified Locking Devices: BHMA A156.25.

4 Lock Trim:

(a) Levers: Cast.
(b) Escutcheons (Roses): Cast.
(c) Dummy Trim: Match lock trim and escutcheons.
(d) Lockset Designs: Provide design indicated on Schedules or, if sets are provided by another manufacturer, provide designs that match those designated.

5 Lock Throw: Comply with testing requirements for length of bolts required for labelled fire doors, and as follows:

(a) Mortise Locks: Minimum 19-mm latch bolt throw.
(b) Deadbolts: Minimum 25-mm bolt throw.

6 Rabbeted Meeting Doors: Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.

7 Back set: 70 mm, unless otherwise indicated.

8 Strikes: Manufacturer's standard strike with strike box for each latch bolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:

(a) Strikes for Mortise Locks and Latches: BHMA A156.13.
(b) Strikes for Interconnected Locks and Latches: BHMA A156.12.
(c) Strikes for Auxiliary Deadlocks: BHMA A156.5.
(d) Flat-Lip Strikes: For locks with three-piece antifriction latch bolts, as recommended by manufacturer.

(e) Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

(f) Aluminium-Frame Strike Box: Manufacturer's special strike box fabricated for aluminium framing.

7.2.7 Mechanical Locks and Latches

1 Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:

   (a) Mortise Locks: BHMA A156.13.

   (b) Interconnected Locks: BHMA A156.12.

2 Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13, Grade 1; Series 1000. Listed under Category F in BHMA's "Certified Product Directory."

3 Interconnected Locks: BHMA A156.12, Grade 1; Series 5000. Listed under Category F in BHMA's "Certified Product Directory."

4 Roller Latches: Rolling plunger that engages socket or catch, with adjustable roller projection, and as follows:

   (a) Material: Brass or Bronze.

   (b) Mounting: Mortise.

5 Push-Pull Latches: Consisting of paddle handles that retract latch bolt; capable of being mounted vertically or horizontally; and as follows:

   (a) Lever and Escutcheon Material: Stainless steel.

   (b) Latch Type: Mortise.

   (c) Lettering: Engrave with the words "Pull" and "Push."

   (d) Lead Lining: 1.2 mm thick for escutcheon plate.

7.2.8 Auxiliary Locks and Latches

1 Auxiliary Locks: BHMA A156.5, Grade 1. Listed under Category E in BHMA's "Certified Product Directory."

   (a) Mortise Auxiliary Locks:

      (i) Material: Stainless steel.

      (ii) Dead latches: Latch bolt and auxiliary dead latch operated by key.

2 Push-Button Combination Locks: BHMA A156.5, Grade 1 for cylindrical
locks, Grade 2 for mortise locks.

(a) Lock opens by entering a one- to five-digit code by pushing correct buttons in correct sequence; automatically relocks when door is closed.

7.2.9 Exit Locks and Exit Alarms

1 Exit Locks: BHMA A156.29, Grade 1, surface mounted; battery powered, housed in metal case; with red-and-white lettering reading "EMERGENCY EXIT PUSH TO OPEN--ALARM WILL SOUND." Include the following features:

(a) Low-battery alert.
(b) Outside key control.
(c) Audible alarm that sounds when unauthorized use of door occurs.
(d) Silent alarm with remote signal capability for connection to remote indicating panel.
(e) Strike: Mortise, unless otherwise indicated.
(f) Single-Door Type: Activated by arm, push plate, or paddle.
(g) Pairs-of-Door Type: Activated by arm, push plate, or paddle.

2 Stand-Alone Exit Alarms: BHMA A156.29, Grade 1. Include the following features:

(a) Low-battery alert.
(b) Outside key control.
(c) Audible alarm that sounds when unauthorized use of door occurs.
(d) Automatic rearming after authorized use[, with adjustable time delay].
(e) Remote signal capability for connection to remote indicating panel.

7.2.10 Door Bolts, General

1 Bolt Throw: Comply with testing requirements for length of bolts required for labelled fire doors, and as follows:

(a) Dutch-Door Bolts: Minimum 19-mm throw.
(b) Mortise Flush Bolts: Minimum 19-mm throw.

2 Dustproof Strikes: BHMA A156.16, Grade 1.

3 Surface Bolts: BHMA A156.16, Grade 1.

(a) Flush Bolt Heads: Minimum of 13-mm diameter rods of stainless steel with minimum 305-mm long rod for doors up to 2134 mm in height. Provide longer rods as necessary for doors exceeding 2134 mm.
7.2.11 Door Bolts

1 Fire-Rated Surface Bolts: 203-mm steel bolt with 2 steel guides; minimum 25-mm throw; listed and labelled for fire-rated doors; with universal strike.

2 Dutch-Door Surface Bolts: Polished-brass bolt and knob, minimum 19-mm throw, with standard strike.

3 Doors with automatic flush bolts must usually be equipped with a coordinator. Some models also require a carry-open bar.

4 Automatic Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically retract when active leaf is opened and that automatically engage when active door depresses bolt trigger; listed and labelled for fire-rated doors. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims.

5 Self-Latching Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically engage when active door depresses trigger; listed and labelled for fire-rated doors. Bolts are manually retracted by a slide in the bolt face. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims.

6 Manual-Extension Flush Bolts: Fabricated from extruded brass or aluminium, with 305-mm rod actuated by flat lever; listed and labelled for fire-rated doors. Provide matching strike.

7 Dustproof Strikes:

   (a) Jamb Type: Polished wrought brass, with 19-mm diameter, spring-tension plunger.

   (b) Floor Type: Polished wrought brass, with 19-mm diameter, spring-tension plunger.

   (c) Locking Floor Type: Polished wrought brass, with 19-mm diameter, spring-tension plunger that can be locked in the up position by rotating plunger.

7.2.12 Exit Devices, General

1 Exit Devices: BHMA A156.3, Grade 1. Listed under Category G in BHMA's "Certified Product Directory."

2 Accessibility Requirements: Where handles, pulls, latches, locks, and other
operating devices are indicated to comply with accessibility requirements, comply with [the U.S. Architectural & Transportation Barriers Compliance Board’s "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." And ANSI A117.1.

(a) Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).

3 Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 67 N to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.

4 Panic Exit Devices: Listed and labelled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

5 Fire Exit Devices: Devices complying with NFPA 80 that are listed and labelled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

6 Fire-Exit Removable Mullions: Provide removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labelled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.


8 Outside Trim: Lever with cylinder; material and finish to match locksets, unless otherwise indicated.

(a) Match design for locksets and latch sets, unless otherwise indicated.

7.2.13 Exit Devices

1 Rim Exit Devices:

(a) Type: BHMA A156.3.
(b) Actuating Bar: Narrow-stile push pad.
(c) Material: Stainless steel.

2 Mortise Exit Devices:

(a) Type: BHMA A156.3, Type 3.
(b) Actuating Bar: Push pad.
3 Surface Vertical-Rod Exit Devices:
   (a) Type: BHMA A156.3.
   (b) Actuating Bar: Push pad.
   (c) Material: Stainless steel.
   (d) Configuration: Top rod.

4 Concealed Vertical-Rod Exit Devices:
   (a) Type: BHMA A156.3.
   (b) Actuating Bar: Push pad.
   (c) Material: Stainless steel.

7.2.14 Lock Cylinders

1 Standard Lock Cylinders: BHMA A156.5, Grade 1.

2 High-Security Lock Cylinders: BHMA A156.30, Grade 1.
   (a) Key Control Level: Category as recommended by manufacture.
   (b) Destructive Test Level: Category as recommended by manufacture.
   (c) Surreptitious Entry Resistance Level: Category as recommended by manufacture.

3 Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
   (a) Number of Pins: Seven.
   (b) Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.

4 Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
   (a) Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers’ cylinders.

5 Construction Keying: Comply with the following:
   (a) Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
   (b) Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.
(i) Replace construction cores with permanent cores as directed by Engineer.

7.2.15 Keying

1 Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:

(a) Master Key System: Cylinders are operated by a change key and a master key.
(b) Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.

2 Keys: Nickel silver.

(a) Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
   (i) Notation: Information to be furnished by Owner.
(b) Quantity: In addition to one extra key blank for each lock, provide the following:
   (i) Cylinder Change Keys: Three.
   (ii) Master Keys: Five.
   (iii) Grand Master Keys: Five.

7.2.16 Key Control System

1 Key Control Cabinet: BHMA A156.5, Grade 1; metal cabinet with baked-enamel finish; containing key-holding hooks, labels, 2 sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers; with key capacity of 150 % of the number of locks.

2 Cross-Index System: Multiple-index system for recording key information. Include three receipt forms for each key-holding hook.

7.2.17 Electric Strikes

1 Standard: BHMA A156.31, Grade 1.

2 General: Use fail-secure electric strikes with fire-rated devices.

   (a) Material: Stainless steel.

7.2.18 Operating Trim, General

1 Standard: BHMA A156.6.

2 Materials: Fabricate from stainless steel, unless otherwise indicated.
7.2.19 Operating Trim

1 Flat Push Plates: 1.3 mm thick, 4 inches wide by 102 mm wide by 406 mm high; with square corners and bevelled edges, secured with exposed screws.

2 Cold-Forged Push Plates: 1.3 mm thick, 102 mm wide by 406 mm high; with square corners and bevelled edges, secured with exposed screws.

3 Push-Pull Plates: 3.2 mm thick, 4 inches wide by 102 mm wide by 406 mm high; with square corners, bevelled edges, and raised integral lip; secured with exposed screws.

4 Straight Door Pulls: 19-mm constant-diameter pull, with minimum clearance of 38 mm from face of door; fastened at 203 mm o.c.

5 Offset Door Pulls: 19-mm constant-diameter pull, with minimum clearance of 38 mm from face of door and offset of 51 mm; fastened at 203 mm o.c.

6 Flush Door Pulls: Mortised 13 mm deep, fastened by screws, and as follows:
   (a) Shape: Rectangular with oval recess.

7 Pull-Plate Door Pulls: 1.3-mm thick plate, 102 mm wide by 406 mm high, with square corners and bevelled edges; 19-mm constant-diameter pull, with minimum clearance of 38 mm from face of door; fastened at 203 mm o.c.

8 Straight Push-Pull Door Pulls: Push-pull plate minimum 125 mm wide by 300 mm high, with minimum clearance of 38 mm from face of door.

9 Single Push Bar: Horizontal bar, with minimum clearance of 38 mm from face of door, and as follows:
   (a) Mounting: Surface applied with concealed fasteners.

7.2.20 Accessories for Pairs of Doors

1 Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
   (a) Material: Polished brass or bronze, with strike plate.

2 Flat Overlapping Astragals: Flat metal bar, surface mounted on face of door with screws; minimum 3.2 mm thick by 50 mm wide by full height of door; and base metal as follows:
   (a) Base Metal: Stainless steel.

7.2.21 Closers, General

1 Accessibility Requirements: Where handles, pulls, latches, locks, and other
operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board’s "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

(a) Comply with the following maximum opening-force requirements:

(i) Interior, Non-Fire-Rated Hinged Doors: 22.2 N applied perpendicular to door.

(ii) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

2 Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 133 N to set door in motion and not more than 67 N to open door to minimum required width.

3 Hold-Open Closers/Detectors: Coordinate and interface integral smoke detector and closer device with fire alarm system.

4 Flush Floor Plates: Provide finish cover plates for floor closers unless thresholds are indicated. Match door hardware finish, unless otherwise indicated.

5 Recessed Floor Plates: Provide recessed floor plates with insert of floor finish material for floor closers unless thresholds are indicated. Provide extended closer spindle to accommodate thickness of floor finish.

6 Size of Units: Unless otherwise indicated, comply with manufacturer’s written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

7 Surface Closers: BHMA A156.4, Grade 1. Listed under Category C in BHMA's "Certified Product Directory." Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.

8 Concealed Closers: BHMA A156.4, Grade 1. Listed under Category C in BHMA's "Certified Product Directory."

9 Closer Holder Release Devices: BHMA A156.15. Listed under Category C in BHMA's "Certified Product Directory."

   (a) Life-Safety Type: On release of hold open, door becomes self-closing. Automatic release is activated by smoke detection system.

10 Coordinators: BHMA A156.3.

7.2.22 Closers

1 Traditional Surface Closers: Rack-and-pinion hydraulic type; with adjustable
sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in a cast-aluminium alloy shell.

(a) Type: Regular arm.
(b) Back check: Adjustable, effective between 60 and 85 degrees of door opening.

2 Modern-Type-with-Cover Surface Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in cover indicated; complying with the following:

(a) Back check: Adjustable, effective between 60 and 85 degrees of door opening.
(b) Cover Material: Plated steel.
(c) Closing Power Adjustment: At least 35 percent more than minimum tested value.

3 Concealed-in-Door-Type Concealed Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; mortised into top rail of minimum 44-mm thick doors and track mortised into head frame; with double lever arm indicated; complying with the following:

(a) Type: Surface shoe.
(b) Arm: Regular.
(c) Closing Power Adjustment: At least 35 % more than minimum tested value.

4 Overhead Concealed Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; mortised into head frame; with cast-metal body and exposed cover plate; complying with the following:

(a) Track: Automatic hold open.
(b) Cover Plate Material: Plated steel.
(c) Back check: Adjustable.
(d) Closing Power Adjustment: At least 35 % more than minimum tested value.

5 Floor Concealed Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with cement case and cast-iron closer body case; for single-acting doors; complying with the following:

(a) Fire Rated: Listed for use with labelled fire doors where indicated.
(b) Back check: Adjustable.
(c) Closing Power Adjustment: At least 35 % more than minimum tested
6 Closer Holder Release Devices: Closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Comply with the following:

(a) Options: Adjustable back check.

7 Coordinators: Consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.

7.2.23 Protective Trim Units, General

1 Size: 38 mm less than door width on push side and 13 mm less than door width on pull side, by height specified in door hardware sets.

2 Fasteners: Manufacturer's standard machine or self-tapping screws.

3 Metal Protective Trim Units: BHMA A156.6; bevelled top and 2 sides; fabricated from the following material:

(a) Material: 1.3-mm thick stainless steel.

7.2.24 Protective Trim Units

1 Kick Plates: 305 mm high by door width, with allowance for frame stops.

2 Mop Plates: 152 mm high by 25 mm less than door width.

7.2.25 Stops and Holders, General

1 Stops and Bumpers: BHMA A156.16, Grade 1.

(a) Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.

2 Mechanical Door Holders: BHMA A156.16, Grade 1.

3 Combination Floor and Wall Stops and Holders: BHMA A156.8, Grade 1.

4 Combination Overhead Stops and Holders: BHMA A156.8, Grade 1.

5 Electromagnetic Door Holders: Coordinate with fire detectors and interface with fire alarm system for labelled fire door assemblies.

(a) Listed under Category C in BHMA's "Certified Product Directory."

6 Silencers for Wood Door Frames: BHMA A156.16, Grade 1; neoprene or rubber,
minimum 16 by 19 mm; fabricated for drilled-in application to frame.

7 Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 13 mm; fabricated for drilled-in application to frame.

7.2.26 Stops and Holders

1 Rigid Wall Stops: Polished cast brass, bronze, or aluminium; 89 mm long, with rubber bumper; expansion-shield application.

2 Wall Bumpers: Polished cast brass or aluminium with rubber bumper; 64-mm diameter, minimum 19-mm projection from wall, with back plate for concealed fastener installation; with concave bumper configuration.

3 Electromagnetic Door Holders: BHMA A156.15, Grade 1; electromagnet attached to wall or floor as indicated, and strike plate attached to swinging door.

4 Combination Floor Stop and Holders: Polished cast brass, bronze, or aluminium; encased spring bumper with metal plunger and stop; and as follows:
   (a) Operation: Automatic hold open and release by pushing door.
   (b) Application: Expansion shield.

5 Combination Wall Stop and Holders: Polished cast brass, bronze, or aluminium; encased spring bumper with metal plunger and stop; surface-screw application; and as follows:
   (a) Operation: Automatic hold open and release by pushing door.

7.2.27 Overhead Stops and Holders

1 Overhead Surface-Mounted, Concealed Slide Stops: BHMA A156.8, Type 2; release by push and pull of door unless control is set in inactive position; with stop and shock absorber; adjustable holding pressure; for single-acting doors opening 110 degrees.

2 Overhead Surface-Mounted, Jointed-Arm Holders: BHMA A156.8, Type 3; hold open and release by push and pull of door; control capable of being set in inactive position; with stop and shock absorber; for single-acting doors opening 110 degrees.

7.2.28 Door Gasketing, General

1 Standard: BHMA A156.22. Listed under Category J in BHMA's "Certified Product Directory."

2 General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled to from fully sealed doors. Provide noncorrosive fasteners for exterior
applications and elsewhere as indicated.

(a) Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

(b) Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

(c) Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3 Air Leakage: Not to exceed 0.000774 cu. m/s per m of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.

4 Smoke-Labelled Gasketing: Assemblies complying with NFPA 105 that are listed and labelled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.

(a) Provide smoke-labelled gasketing on 20-minute-rated doors and on smoke-labelled doors.

5 Fire-Labelled Gasketing: Assemblies complying with NFPA 80 that are listed and labelled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

(a) Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 1016 mm or less above the sill.

6 Sound-Rated Gasketing: Assemblies that are listed and labelled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

7 Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.


7.2.29 Door Gasketing

1 Rigid, Housed, Perimeter Gasketing: Gasket material held in place by metal housing; fastened to frame stop with screws.

   (a) Gasket Material: Sponge silicone or sponge neoprene.

   (b) Housing Material: Stainless steel.

2 Interlocking Perimeter Gasketing: Metal gasket material consisting of two pieces, one fastened to door and one fastened to frame, that interlock when door is closed; mounted with screws.
3 Overlapping Astragals for Meeting Stiles: Gasket material held in place by metal housing and overlapping when doors are closed; mounted to face of meeting stile with screws.

(a) Gasket Material: EPDM strip.
(b) Housing Material: Aluminium.
(c) Mounting: Surface mounted to each door.

4 Meeting Astragals for Meeting Stiles: Gasket material held in place by metal housing; mounted with screws.

(a) Gasket Material: Neoprene.
(b) Housing Material: Aluminium.
(c) Mounting: Mortised into edge of each door.

5 Adjustable Astragals for Meeting Stiles: Screw-adjustable gasket material held in place by metal housing; mounted with screws.

(a) Gasket Material: Neoprene.
(b) Housing Material: Aluminium.
(c) Mounting: Mortised into edge of each door.

6 Door Sweeps: Gasket material held in place by flat metal housing or flange; surface mounted to face of door with screws.

(a) Gasket Material: Neoprene.
(b) Housing Material: Aluminium.

7 Door Shoes: Gasket material held in place by metal housing; mounted to bottom edge of door with screws.

(a) Gasket Material: Neoprene.
(b) Housing Material: Aluminium.
(c) Mounting: Mortised into bottom edge of door.

8 Automatic Door Bottoms: Gasket material held in place by metal housing that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.

(a) Gasket Material: Nylon brush.
(b) Housing Material: Aluminium.
(c) Mounting: Mortised into bottom of door.
(d) Type: Low-closing-force type for doors required to meet accessibility requirements.

7.2.30 Thresholds, General

1 Standard: BHMA A156.21. Listed under Category J in BHMA's "Certified Product Directory."

2 Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with [the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."

(a) Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 13 mm high.


7.2.31 Thresholds

1 Compressing-Top Thresholds: Metal member with compressible vinyl seal on top of threshold that seals against bottom of door; and base metal of aluminium.

2 Saddle Thresholds: Type and base metal as follows:

(a) Type: Fluted top.

(b) Base Metal: Aluminium.

7.2.32 Miscellaneous Door Hardware, General

1 Boxed Power Supplies: Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; and listed and labelled for use with fire alarm systems.

2 Monitor Strikes: Cast strike with toggle.

3 Auxiliary Hardware: BHMA A156.16, Grade 1.

7.2.33 Fabrication

1 Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

(a) Manufacturer's identification is permitted on rim of lock cylinders only.
2 Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

3 Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminium fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

(a) Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

(b) Steel Machine or Wood Screws: For the following fire-rated applications:

(i) Mortise hinges to doors.
(ii) Strike plates to frames.
(iii) Closers to doors and frames.

(c) Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:

(i) Surface hinges to doors.
(ii) Closers to doors and frames.
(iii) Surface-mounted exit devices.

(d) Spacers or Sex Bolts: For through bolting of hollow-metal doors.

(e) Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteniers for Wood Doors."

7.2.34 Finishes

1 Standard: BHMA A156.18, as indicated in door hardware sets.

2 Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3 Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of...
approved Samples and are assembled or installed to minimize contrast.

7.3 EXECUTION

7.3.1 Examination

1. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labelled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

2. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

7.3.2 Preparation

1. NFPA 80 restricts on-site door preparation to that required for surface-applied door hardware, function holes for mortise locks, holes for labelled viewers, undercutting of doors, and protection plates.

2. Steel Doors and Frames: Comply with DHI A115 Series.
   
   (a) Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.


7.3.3 Installation

1. Mounting Heights: Mount door hardware units at heights indicated [on Drawings] [as follows] unless otherwise indicated or required to comply with governing regulations.

   (a) Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

   (b) Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

2. Install each door hardware item to comply with manufacturer’s written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Section 24. Do not install surface-mounted items until finishes have been completed on substrates involved.

   (a) Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

   (b) Drill and countersink units that are not factory prepared for anchorage
fasteners. Space fasteners and anchors according to industry standards.

3 Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

4 Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings in equipment room. Verify location with Engineer.

   (a) Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.

5 Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 24 Part "Joint Sealants."

7.3.4 Field Quality Control

1 Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

   (a) Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

7.3.5 Adjusting

1 Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

   (a) Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

   (b) Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 75 mm from the latch, measured to the leading edge of the door.

2 Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer’s Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

7.3.6 Cleaning and Protection

1 Clean adjacent surfaces soiled by door hardware installation.
2 Clean operating items as necessary to restore proper function and finish.

3 Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

7.3.7 Demonstration

1 Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.
SECTION 19

PLUMBING WORK
7. COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

7.1 GENERAL

7.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

7.1.2 Summary

1 This Section includes the following:

(a) Dental air piping and specialties, designated "dental air," operating at 550 to 600kPa.

7.1.3 Definitions

1 D.I.S.S.: Diameter-index safety system.

2 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

3 Compressed-Air Piping Systems: Include air piping systems.

7.1.4 Submittals

1 Product Data: For the following:

(a) Compressed-air tubes and fittings.

(b) Compressed-air valves and zone valve boxes.

(c) Dental compressed-air service connections.

(d) Dental compressed-air pressure control panels.

(e) Dental compressed-air alarm system components.

2 Shop Drawings: Diagram power, signal, and control wiring.

3 Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with HTM 02-01 and HTM 2022 – SUPPLEMENT 1.

4 Qualification Data: For Installer and testing agency.

5 Brazing certificates.

6 Field quality-control test reports.

7 Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.
7.1.5 Quality Assurance

1 Installer Qualifications:
   (a) Dental Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   (b) Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

2 Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   (a) Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

3 Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided


5 Electrical Components, Devices, and Accessories: Listed and labeled as defined in HTM 02-01.

6 Comply with HTM 02-01 and HTM 2022 – SUPPLEMENT 1, “health technical memorandum,” for medical compressed-air system materials and installation in healthcare facilities.

7.1.6 Project Conditions

1 Interruption of Existing dental Compressed-Air Service(s): Do not interrupt dental compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   (a) Notify Construction Manager no fewer than two days in advance of proposed interruption of dental compressed-air service(s).
   (b) Do not proceed with interruption of dental compressed-air service(s) without Owner's written permission.

7.1.7 Coordination

1 Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements

2 Coordinate dental compressed-air service connections with other service connections.

7.1.8 Extra Materials

1 Furnish extra materials described below that match products installed and that
are packaged with protective covering for storage and identified with labels describing contents.

(a) Quick-Coupler Service Connections: Furnish complete non interchangeable dental compressed-air pressure outlets.
   i) Dental Compressed-Air Service Connections: Equal to percent of amount installed, but no fewer than units.
   ii) Gas-Powered-Tool, Compressed-Air Service Connections: Equal to percent of amount installed, but no fewer than units.

(b) D.I.S.S. Connections: Furnish complete non interchangeable dental compressed-air pressure outlets complying with CGA V-5.
   i) Compressed-Air D.I.S.S. No. 1160: Equal to percent of amount installed, but no fewer than units.

7.2 PRODUCTS

7.2.1 Pipes, Tubes, And Fittings

1 Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.

(a) General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

(b) Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

(c) Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

(d) Press-Type Fittings:
   i) DN 50 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
   ii) DN 65 to DN 100: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

2 Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

3 Copper Water Tube: ASTM B 88M, Type C, seamless, drawn temper.

(a) Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.

(b) Press-Type Fittings:
   i) DN 50 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
   ii) DN 65 to DN 100: Bronze fitting with stainless-steel grip ring and
EPDM O-ring seal in each end.

7.2.2 Joining Materials


2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

3. Threaded-Joint Tape: PTFE.


7.2.3 Valves

1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

2. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   (a) Pressure Rating: 2070 kPa minimum.
   (b) Ball: Full-port, chrome-plated brass.
   (c) Seats: PTFE.
   (d) Handle: Lever [type with locking device].
   (e) Stem: Blowout proof with PTFE seal.
   (f) Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

3. Check Valves: In-line pattern, bronze.
   (a) Pressure Rating: 600 kPa minimum.
   (b) Operation: Spring loaded.
   (c) Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   (a) Pressure Rating: 2070 kPa minimum.
   (b) Ball: Full-port, chrome-plated brass.
   (c) Seats: PTFE.
   (d) Handle: Lever [type with locking device].
   (e) Stem: Blowout proof with PTFE seal.
   (f) Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   (g) Pressure Gage: Manufacturer installed on one copper-tube extension.

5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or
multiple valves with pressure gages and in sizes required to permit manual operation of valves.

(a) Interior Finish: Factory-applied white enamel.
(b) Cover Plate: Satin-chrome finish steel with frangible or removable windows.
(c) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served.

6 Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

(a) Interior Finish: Factory-applied white enamel.
(b) Cover Plate: Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
(c) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served.

7 Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

8 Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 1725-kPa minimum inlet.

9 Automatic Drain Valves: Stainless-steel body and internal parts, rated for 175-kPa minimum working pressure, capable of automatic discharge of collected condensate.

7.2.4 Dental Compressed-Air Service Connections

1 Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

(a) Roughing-in Assembly:
   i) Steel outlet box for recessed mounting and concealed piping.
   ii) Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
   iii) Double seals that will prevent air leakage.
   iv) ASTM B 819, DN 10 copper outlet tube brazed to valve with service marking and tube-end dust cap.

(b) Finishing Assembly:
   i) Brass housing with primary check valve.
ii) Double seals that will prevent air leakage.
iii) Cover plate with gas-service label.

(c) Quick-Coupler Service Connections: Pressure outlet with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

(d) D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.


(e) Cover Plates: One piece, stainless steel, with NAAMM AMP 503 finish and permanent, color-coded, identifying label matching corresponding service.

7.2.5 Dental Compressed-Air Pressure Control Panels

1 Description: Steel box and support brackets for recessed roughing in with stainless-steel cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.

(b) Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
(c) Pressure Gages: 0- to 2070-kPa range.
(d) Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
(e) Before final assembly, provide temporary dust shield and U-tube for testing.
(f) Label cover plate "Air Pressure Control."

7.2.6 Dental Compressed-Air-Piping Alarm Systems

1 Panels for dental compressed-air piping systems may be combined in single panels with dental vacuum and medical gas piping systems.

2 Components: Designed for continuous service and to operate on power supplied from 400V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

3 Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 4 deg C at 380 kPa.

(a) Operation: Hygrometer moisture analyzer with sensor probe.

4 Pressure Switches or Transducer Sensors: Continuous line monitoring with
electrical connections for alarm system.

(a) Low-Pressure Operating Range: 0- to 550-kPa.
(b) High-Pressure Operating Range: Up to 1725-kPa.

5 Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

6 General Requirements for Dental Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

(a) Mounting: Recessed installation.
(b) Enclosures: Fabricated from minimum 1.2-mm- thick steel or minimum 1.27-mm- thick aluminum, with knockouts for electrical and piping connections.

7 Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

(a) Include alarm signals when the following conditions exist:
   i) Dental Air: Pressure drops below 440 kPa or rises above 660 kPa, backup air compressor is in operation, pressure drop across filter assembly increases more than 13.8 kPa, dew point rises above 4 deg C at 550 kPa, carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.

8 Anesthetizing-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

(a) Include alarm signals when the following conditions exist:
   i) Dental Air: Pressure drops below 440 kPa or rises above 660 kPa.

9 Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

(a) Include alarm signals when the following condition exists:
   i) Dental Air: Pressure drops below 440 kPa or rises above 660 kPa.

7.2.7 Flexible Pipe Connectors

1 Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

(a) Working-Pressure Rating: [(1380 kPa) (1725 kPa)] minimum.
(b) End Connections: Threaded copper pipe or plain-end copper tube.

7.2.8 Sleeves

1 Galvanized-Steel Sheet: 0.6-mm minimum thickness; round tube closed with
welded longitudinal joint. Pipe Sleeve should be greater than pipe diameter by 1" for small pipe < 2" and double size for pipe > 2" according to steel schedule 10.

2 Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

(a) Under deck Clamp: Clamping ring with set screws.

7.2.9 Escutcheons

1 General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

2 One-Piece, Deep- Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

3 One-Piece, Cast-Brass Escutcheons: With set screw.

(a) Finish: Polished chrome-plated and rough brass.

4 Split- Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

(a) Finish: Polished chrome-plated and rough brass.

5 One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

6 Split-Plate, Stamped-Steel Escutcheons: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

7 One-Piece, Floor-Plate Escutcheons: Cast iron.

8 Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

7.2.10 Grout

1 Description: ASTM C 1107, Grade B, no shrink and nonmetallic, dry hydraulic-cement grout.

(a) Characteristics: Post-hardening, volume adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

(b) Design Mix: 34.5-MPa, 28-day compressive strength.

(c) Packaging: Premixed and factory packaged.

7.3 EXECUTION

7.3.1 preparation

1 Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if pre cleaned fittings or tubing must be recleaned.
because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

(a) Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

(b) Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 0.453 kg of chemical to 11.3 L of water.
   i) Scrub to ensure complete cleaning.
   ii) Rinse with clean, hot water to remove cleaning solution.

7.3.2 Piping Applications

1 Connect new tubing to existing tubing with memory-metal couplings.

2 Dental Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

7.3.3 Retain "One Of" Option In Paragraph Below To Allow Contractor To Select Piping Materials From Those Retained.

7.3.4 Piping Installation

1 Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

2 Comply with ASSE Standard #6010 for installation of compressed-air piping.

3 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

4 Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

6 Install piping adjacent to equipment and specialties to allow service and maintenance.

7 Install air and drain piping with 1 percent slope downward in direction of flow.

8 Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
9 Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

10 Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

11 Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver.

12 Install piping to permit valve servicing.

13 Install piping free of sags and bends.

14 Install fittings for changes in direction and branch connections.

15 Install dental compressed-air piping to dental compressed-air service connections specified in this Section.

16 Install seismic restraints on compressed-air piping.

17 Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

18 Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

19 Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

7.3.5 **Valve Installation**

1 Install shutoff valve at each connection to and from compressed-air equipment and specialties.

2 Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.

3 Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

4 Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

5 Install safety valves on compressed-air receivers where required by HTM 02-01 and where recommended by specialty manufacturers.

6 Install pressure regulators on compressed-air piping where reduced pressure is required.

7 Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.
7.3.6 Joint Construction

1 Ream ends of PVC pipes and remove burrs.

2 Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

3 Threaded Joints: Apply appropriate tape to external pipe threads.

4 Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

5 Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

6 Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.

7 Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

8 Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:

   (a) Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

   (b) Apply primer and join according to ASME B31.9 for solvent-cemented joints, and ASTM D 2672.

7.3.7 Compressed-Air Service Component Installation

1 Install compressed-air pressure control panel in walls. Attach to substrate.

2 Install compressed-air manifolds [on concrete base] anchored to substrate.

3 Install compressed-air cylinders and connect to manifold piping.

4 Install compressed-air manifolds with seismic restraints as indicated.

5 Install compressed-air-cylinder wall storage racks attached to substrate.

7.3.8 Medical Compressed-Air-Piping Alarm System Installation

1 Alarm panels for medical compressed-air piping systems may be combined in single panels with dental vacuum piping systems and medical gas piping systems.

2 Install alarm system components for medical compressed-air-piping according to and in locations required by HTM 02-01.

3 Install area and master alarm panels for medical compressed-air piping system
where indicated.

4 Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

7.3.9 Sleeve Installation

1 Sleeves are not required for core-drilled holes.

2 Permanent sleeves are not required for holes formed by removable PE sleeves.

3 Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe.

(a) Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.

(b) Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 50 mm above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

4 Install sleeves in new walls and slabs as new walls and slabs are constructed.

5 Install sleeves that are large enough to provide 10-mm annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

(a) Steel Pipe Sleeves: For pipes smaller than DN 150.

(b) Steel Sheet Sleeves: For pipes DN 150 and larger is penetrating gypsum board partitions.

(c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 50 mm above finished floor level.

i) Seal space outside of sleeve fittings with grout.

6 Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials.

7.3.10 Escutcheon Installation

1 Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

(a) New Piping:

i) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.

ii) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

iii) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
iv) Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.

v) Bare Piping in Equipment Rooms: One piece, stamped steel with spring clips. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

7.3.11 Hanger and Support Installation

1 Vertical Piping: MSS Type 8 or 42, clamps.

2 Individual, Straight, Horizontal Piping Runs:
   (a) 30 m and Less: MSS Type 1, adjustable, steel, clevis hangers.
   (b) Longer Than 30 m: MSS Type 43, adjustable, roller hangers.

3 Multiple, Straight, Horizontal Piping Runs 30 m or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4 Base of Vertical Piping: MSS Type 52, spring hangers.

5 Support horizontal piping within 300 mm of each fitting and coupling.

6 Rod diameter may be reduced 1 size for double-rod hangers, with 10-mm minimum rods.

7 Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   (a) DN 8: 1500 mm with 10-mm rod.
   (b) DN 10 and DN 15: 1800 mm with 10-mm rod.
   (c) DN 20: 2100 mm with 10-mm rod.
   (d) DN 25: 2400 mm with 10-mm rod.
   (e) DN 32: 2700 mm with 10-mm rod.
   (f) DN 40: 3 m with 10-mm rod.
   (g) DN 50: 3.4 m with 10-mm rod.
   (h) DN 65: 4 m with 13-mm rod.
   (i) DN 80: 4.3 m with 13-mm rod.
   (j) DN 90: 4.6 m with 13-mm rod.
   (k) DN 100: 4.9 m with 13-mm rod.
   (l) DN 125: 5.5 m with 13-mm rod.
   (m) DN 150: 6 m with 16-mm rod.
   (n) DN 200: 7 m with 19-mm rod.

8 Install supports for vertical copper tubing every 3 m.
7.3.12 Labeling And Identification

1 Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties.

2 Pipelines should be identified in accordance with BS 1710:1984, and color banding for the pipelines should be used.

7.3.13 Field Quality Control For Compressed-Air Piping In Nonmedical Laboratory Facilities

1 Testing Agency: Engage qualified testing agency to perform field tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.

2 Perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.

3 Tests and Inspections:

   (a) Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry nitrogen to pressure of 345 kPa above system operating pressure, but not less than 1035 kPa. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

   (b) Repair leaks and retest until no leaks exist.

   (c) Inspect filters and pressure regulators for proper operation.

7.3.14 Field Quality Control For Medical Compressed-Air Piping In Healthcare Facilities

1 Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.

2 Perform tests and inspections of dental compressed-air piping systems in healthcare facilities and prepare test reports.

3 Tests and Inspections:

   (a) Dental Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of dental compressed-air piping systems concurrently with tests, inspections, and certification of dental vacuum piping and medical gas piping systems.

   (b) Preparation: Perform the following Installer tests according to requirements in HTM 02-01 and ASSE Standard #6010:

      i) Initial blow down.

      ii) Initial pressure test.

      iii) Cross-connection test.
iv) Piping purge test.

v) Standing pressure test for positive-pressure medical compressed-air piping.

vi) Repair leaks and retest until no leaks exist.

(c) System Verification: Comply with requirements in HTM 02-01, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:

i) Standing pressure test.

ii) Individual-pressurization or pressure-differential cross-connection test.

iii) Valve test.

iv) Master and area alarm tests.

v) Piping purge test.

vi) Piping particulate test.

vii) Piping purity test.

viii) Final tie-in test.

ix) Operational pressure test.

x) Medical air purity test.

xi) Verify correct labeling of equipment and components.

(d) Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

i) Inspections performed.

ii) Procedures, materials, and gases used.

iii) Test methods used.

iv) Results of tests.

4 Remove and replace components that do not pass tests and inspections and retest as specified above.

7.3.15 Demonstration

1 Train Owner’s maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems.
8. COMPRESSED-AIR EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES

8.1 GENERAL

8.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General and Supplementary Conditions

8.1.2 Summary

1 Section Includes:

   (a) Packaged, rotary-screw air compressors.
   (b) Inlet-air filters.
   (c) Desiccant compressed-air dryers.
   (d) Compressed-air filter assemblies.
   (e) Medical compressed-air equipment alarm systems.

8.1.3 Definitions

1 Actual Air: Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in actual L/min.

2 Laboratory Air Equipment: Compressed-air equipment and accessories for nonmedical laboratory facilities.

3 Medical Air Equipment: Compressed-air equipment and accessories for healthcare facilities.

4 Standard Air: Free air at 20 deg C and 29.92 in. Hg before compression or expansion and measured in standard L/min.

8.1.4 Performance Requirements

1 Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2 Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to [SEI/ASCE 7].

   (a) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [and the unit will be fully operational after the seismic event]."
8.1.5 Submittals

1 Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

   (a) Wiring Diagrams: For power, signal, and control wiring.

2 Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

   (a) Detail fabrication and assembly of supports.
   (b) Design Calculations: Calculate requirements for selecting vibration isolators [and seismic restraints] and for designing vibration isolation bases.

3 Qualification Data: For qualified [Installer] [and] [testing agency].

4 Seismic Qualification Certificates: For [air compressors,] accessories, and components, from manufacturers.

   (a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   (b) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   (c) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

5 Field quality-control reports.

6 Operation and Maintenance Data: For compressed-air equipment to include in operation and maintenance manuals.

8.1.6 Quality Assurance

1 Installer Qualifications:

   (a) Dental Air System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

2 Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is [a member of the Medical Gas Professional Healthcare Organization or is] an NRTL and that is acceptable to authorities having jurisdiction.

   (a) Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

3 ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.
4 Comply with HTM 02-01, "Health Care Facilities," for compressed-air equipment and accessories for medical air systems.

5 Comply with HTM 2022 – SUPPLEMENT 1, "Dental compressed air and vacuum systems" for dental gases equipment.

8.1.7 Project Conditions

1 Interruption of Existing Dental Compressed-Air Service(s): Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

(a) Notify Construction Manager no fewer than [two] days in advance of proposed interruption of service.

(b) Do not proceed with interruption of service without Owner's written permission.

8.1.8 Coordination

1 Coordinate sizes and locations of concrete bases with equipment provided.

8.1.9 Extra Materials

1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

(a) Air-Compressor, Inlet-Air Filter Elements: Equal to percent of amount installed, but no fewer than units.

8.2 PRODUCTS

8.2.1 general Requirements For Packaged Air Compressors

1 Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

2 Control Panels: Automatic control station with load control and protection functions. Comply with HTM 02-01.

(a) Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.

(b) Motor Controllers: Full-voltage, combination-magnetic type with under voltage release features and motor-circuit-protector-type disconnecting means and short-circuit protective device.

(c) Control Voltage: 120-V ac or less, using integral control power transformer.

(d) Motor Overload Protection: Overload relay in each phase.

(e) Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.

(f) Automatic control switches to sequence lead-lag air compressors for multiplex air compressors.
(g) Instrumentation: Include discharge-air and receiver pressure gages, air-filter maintenance indicator, hour meter, air-compressor discharge-air and coolant temperature gages, and control transformer.

(h) Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.

3 Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

(a) Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.

(b) Interior Finish: Corrosion-resistant coating.

(c) Accessories: Include safety valve, pressure gage, automatic drain, and pressure regulator.

4 Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

8.2.2 Rotary-Screw Air Compressors

1 Description: Packaged unit.

2 Air Compressor(s): Single-stage, oil-free, rotary, helical-screw type with non-lubricated helical screws and lubricated gearbox, and of construction that prohibits oil from entering compression chamber.

(a) Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package pre-piped to unit; with air-pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal-bypass valve.

(b) Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.

(c) Air/Coolant Receiver and Separation System: 1300-kPa- rated steel tank with ASME safety valve, coolant-level gage, multistage air-coolant separator element, minimum pressure valve, blow down valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal-bypass valve.

(d) Capacity Control: Capacity modulation between 0 and 100 percent air delivery, with operating pressures between 600 and 800 kPa. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blow down valve.

(e) Mounting: Freestanding.

3 Sound-attenuation enclosure.

4 Capacities and Characteristics per package:

5 For the Capacities and Characteristics:

6 For Al Shamal Site (Type C) refer To DWG No MG-50-601
8.2.3 Inlet-Air Filters

1 Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.

(a) Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.

(b) Capacity: Match total capacity of connected air compressors, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

8.2.4 Desiccant Compressed-Air Dryers

1 Description: Twin-tower unit with purge system, mufflers, and capability to deliver [minus 12 deg C], 600kPa air at dew point. Include dew point controlled purge, step-down transformers; disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

2 Capacities and Characteristics:

(a) Standard-Air Capacity of Each Compressed-Air Dryer: 135 L/min.
(b) Pressure: 600 kPa.
(c) Entering-Air Temperature: 40 deg C.
(d) Leaving-Air Temperature: 50 deg C.
(e) Maximum Air-Pressure Drop: 50 kPa.
(g) Outlet Filter: [1] micrometer(s).
(h) Electrical Characteristics:
   i) Volts: 380 V
   ii) Phase(s): Three.
   iii) Hertz: 60 Hz.

8.2.5 Compressed-Air Filter Assemblies

1 Description: Filter assemblies suitable for compressed air, in parallel duplex arrangement. Size each assembly for maximum capacity of connected equipment and operating pressure of compressed-air system. Include automatic ejection of condensate from airstream, inlet and outlet pressure gages, and shutoff valves.

(a) Option: Factory-fabricated filter system consisting of three air filters equivalent to those specified, pipe, fittings, valves, differential pressure switch, and enclosure; and with additional automatic drain traps and gages.

(b) Size filter assemblies for 34.5-kPa maximum air-pressure drop when filters are new and clean, at system rated capacity, and at 600-kPa pressure.

(c) Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than 13.8 kPa greater than when new and clean.
(d) Particulate Filters: Collection efficiency of 98 percent retention of particles 1 micrometer and larger.

(e) Odor and Taste Filters: Vapor-absorbing, activated charcoal.

(f) Coalescing Filters: Collection efficiency of 99.9 percent retention of particles 0.3 micrometer and smaller.

(g) Include automatic drain trap for each filter.

8.2.6 Medical Compressed-Air Equipment Alarm Systems

1 General Requirements for Medical Compressed-Air Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by HTM 02.

2 Components: Designed for continuous service and to operate on power supplied from 120V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

3 Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 3.9 deg C at 550 kPa.

(a) Operation: Hygrometer moisture analyzer with sensor probe.

4 Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

(a) Low-Pressure Switches: 0- to 800-kPa operating range.

(b) High-Pressure Switches: Up to 1300-kPa operating range.

5 Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

6 General Requirements for Dental Compressed-Air Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

(a) Mounting: Recessed installation.

(b) Enclosures: Fabricated from minimum 1.2-mm- thick steel or minimum 1.27-mm- thick aluminum, with knockouts for electrical and piping connections.

7 Local and Master Alarm Panels: Separate trouble alarm signals and pressure gages to indicate function of medical compressed-air equipment when the following conditions exist:

(a) Dental Air, Compressed-Air Equipment: Pressure drops below 600 kPa or rises above 800 kPa, backup air compressor is in operation, pressure drop across filter assembly increases more than 15.2MPa, dew point rises above
3.9 deg C at 550 kPa, carbon monoxide level rises above 10 ppm, and the following:

i) Oil-Free, Rotary-Screw Air-Compressor Equipment: High discharge-air temperature and high water level in receiver.

8.2.7 Motors

1 Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors

(a) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven loads will not require motor to operate in service factor range above 1.0.

(b) Controllers, Electrical Devices, and Wiring.

8.3 EXECUTION

8.3.1 preparation

1 Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

8.3.2 Compressed-Air Equipment Installation

1 General Requirements for Compressed-Air Equipment Installation:

(a) Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.

(b) Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.

(c) Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

(d) Install equipment to allow right of way for piping installed at required slope.

(e) Install the following devices on compressed-air equipment:

i) Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.

ii) Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.

iii) Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

2 Dental Compressed-Air Equipment Installation:

(a) Install according to HTM 02-01.
(b) Install compressed-air equipment, except wall-mounting equipment, on concrete bases. Install units anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.

i) Anchor equipment to concrete bases according to manufacturer's written instructions [and seismic criteria applicable to Project].

   1) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   2) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   3) Install anchor bolts to elevations required for proper attachment to supported equipment.

ii) Vibration Isolation: Install [spring] [restrained-spring] isolators with a minimum deflection of Vibration isolation devices and installation requirements

iii) Vibration Isolation: Mount equipment on a vibration isolation equipment base

8.3.3 Equipment Alarm System Installation

1. Alarm panels for medical compressed-air equipment may be combined in single panels with medical vacuum equipment and medical gas piping systems.

2. Install medical compressed-air equipment alarm system components in locations required by and according to HTM 02-01.

3. Install medical compressed-air equipment local and master alarm panels where indicated.

8.3.4 Computer Interface Cabinet Installation

1. Install computer interface cabinet with connection [to medical compressed-air piping alarm system and] to facility computer.

8.3.5 Connections

1. Comply with requirements for water-supply piping Drawings indicate general arrangement of piping, fittings, and specialties.

2. Comply with requirements for drain piping Drawings indicate general arrangement of piping, fittings, and specialties.

3. Comply with requirements for compressed-air piping Drawings indicate general arrangement of piping, fittings, and specialties.

4. Install piping adjacent to equipment to allow service and maintenance.

5. Connect compressed-air piping to compressed-air equipment, accessories, and specialties with shutoff valve and union or flanged connection.
6 Connect water supply to compressed-air equipment that requires water. Include backflow preventer.

8.3.6 Identification

1 Identify nonmedical laboratory compressed-air equipment system components.

2 Identify medical compressed-air equipment system components. comply with HTM 02-01.

8.3.7 Field Quality Control For Healthcare-Facility Medical Compressed-Air Equipment

1 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

2 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3 Perform tests and inspections.
   (a) Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

4 Tests and Inspections:
   (a) Medical Compressed-Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air equipment concurrently with tests, inspections, and certification of medical vacuum equipment medical compressed-air piping systems.
   (b) Preparation: Perform medical compressed-air equipment tests according to requirements in HTM 02-01 for the following:
      i) Air-quality purity test.
      ii) System operation test.
   (c) Equipment Verification: Comply with requirements in HTM 02-01 for verification of medical compressed-air equipment.
   (d) Replace damaged and malfunctioning controls and equipment.
   (e) Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
      i) Inspections performed.
      ii) Procedures, materials, and gases used.
      iii) Test methods used.
      iv) Results of tests.

5 Components will be considered defective if they do not pass tests and inspections.
6 Prepare test and inspection reports.

8.3.8 Startup Service

1 Engage a factory-authorized service representative to perform startup service.

   (a) Complete installation and startup checks according to manufacturer's written instructions.

   (b) Verify that air-compressor inlet filters and piping are clear.

   (c) Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.

   (d) Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.

   (e) Check for proper seismic restraints.

   (f) Drain receiver tanks.

   (g) Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

   (h) Test and adjust controls and safeties.

8.3.9 Demonstration

1 Train Owner's maintenance personnel to adjust, operate, and maintain air compressors[, compressed-air dryers and compressed-air filter assemblies].
9. VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

9.1 GENERAL

9.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

9.1.2 Summary

1 This Section includes the following:

(a) Dental surgical vacuum piping and specialties, designated "dental vacuum" operating at 135 mm mercury or 18 kPa vacuum & 188 mm mercury or 25 kpa .

9.1.3 Definitions

1 D.I.S.S.: Diameter-index safety system.

2 Low Voltage: As defined for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

3 Dental vacuum piping systems include dental vacuum piping systems.

9.1.4 Submittals

1 Product Data: For the following:

(a) Vacuum pipes &tubes and fittings.

(b) Vacuum valves and valve boxes.

(c) dental vacuum service connections and vacuum-bottle brackets.

2 LEED Submittal:

(a) Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

3 Shop Drawings: Diagram power, signal, and control wiring.

4 Piping Material Certification: Signed by Installer certifying that dental vacuum piping materials comply with HTM 02-01 requirements.

5 Qualification Data: For Installer and testing agency.

6 Brazing certificates.

7 Field quality-control test reports.

8 Operation and Maintenance Data: For vacuum piping specialties to include in
emergency, operation, and maintenance manuals.

9.1.5 Quality Assurance

1 Installer Qualifications:

(a) Dental Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

(b) Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.

(c) Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

2 Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

   (a) Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

3 Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided


5 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

6 Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.

7 NFPA Compliance: Comply with HTM 02-01, "Health Care Facilities," for dental vacuum system materials and installation in healthcare facilities.

9.1.6 Project Conditions

1 Interruption of Existing Dental Vacuum Service(s): Do not interrupt Dental vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

   (a) Notify Construction Manager no fewer than two days in advance of proposed interruption of dental vacuum service(s).

   (b) Do not proceed with interruption of Dental vacuum service(s) without Owner's written permission.
9.1.7 Coordination

1 Coordinate Dental vacuum service connections with other service connections. Dental compressed-air service connections

9.1.8 Extra Materials

1 Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

(a) Quick-Coupler Service Connections: Furnish complete non interchangeable dental vacuum suction inlets.
   i) Dental Vacuum Service Connections: Equal to percent of amount installed, but no fewer than units.

(b) D.I.S.S. Connections: Furnish complete non interchangeable dental vacuum suction inlets complying with CGA V-5.
   i) Dental Vacuum D.I.S.S. No. 1220: Equal to percent of amount installed, but no fewer than units.

(c) Dental Vacuum Bottle Brackets: Equal to percent of amount installed, but no fewer than units.

9.2 PRODUCTS

9.2.1 Pipes, Tubes, And Fittings

1 Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.

(a) General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

(b) Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

(c) Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

(d) Press-Type Fittings:
   i) DN 50 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
   ii) DN 65 to DN 100: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

2 Copper Water Tube: ASTM B 88M, Type C, seamless, drawn temper.

(a) Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.

(b) Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.

(c) Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
(d) Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

(e) Press-Type Fittings:
   i) DN 50 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
   ii) DN 65 to DN 100: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.


4 Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

9.2.2 Joining Materials

1 Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2 Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

3 Threaded-Joint Tape: PTFE.

4 Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 3.2-mm maximum thickness, full-face type.

5 Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

   (a) Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   (b) Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

9.2.3 Valves

1 General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
   (a) Exception: Factory cleaning and bagging are not required for valves for WAGD service.

2 Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   (a) Pressure Rating: 2070 kPa minimum.
   (b) Ball: Full-port, chrome-plated brass.
   (c) Seats: PTFE.
(d) Handle: Lever type with locking device.
(e) Stem: Blowout proof with PTFE seal.
(f) Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

3 Bronze Check Valves: In-line pattern.
(a) Pressure Rating: 2070 kPa minimum.
(b) Operation: Spring loaded.
(c) Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

4 Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
(a) Pressure Rating: 2070 kPa minimum.
(b) Ball: Full-port, chrome-plated brass.
(c) Seats: PTFE.
(d) Handle: Lever type with locking device.
(e) Stem: Blowout proof with PTFE seal.
(f) Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
(g) Vacuum Gage: Manufacturer installed on one copper-tube extension.

5 Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
(a) Interior Finish: Factory-applied white enamel.
(b) Cover Plate: Satin-chrome finish steel with frangible or removable windows.
(c) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to HTM 02-01.

6 Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
(a) Interior Finish: Factory-applied white enamel.
(b) Cover Plate: Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
(c) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to HTM 02-01.

7 Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

8 Automatic Drain Valves: Stainless-steel body and internal parts, rated for 1380-kPa minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.
9.2.4 Dental Vacuum Service Connections

1 Connection Devices: For specific dental vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

(a) Roughing-in Assembly:
   i) Steel outlet box for recessed mounting and concealed piping.
   ii) Brass-body inlet block.
   iii) Seals that will prevent vacuum leakage.
   iv) ASTM B 819, DN 10 copper outlet tube brazed to valve with service marking and tube-end dust cap.

(b) Finishing Assembly:
   i) Brass housing with primary check valve.
   ii) Seals that will prevent vacuum leakage.
   iii) Cover plate with gas-service label.

(c) Quick-Coupler Service Connections: Suction inlets for dental vacuum service outlets with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

(d) D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

(e) Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

9.2.5 Dental Vacuum Piping Alarm Systems

1 Panels for dental vacuum piping systems may be combined in single panels with dental compressed-air and medical gas piping systems.

2 Components: Designed for continuous service and to operate on power supplied from 240-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

3 Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   (a) Vacuum Operating Range: 0- to 101-kPa vacuum.

4 General Requirements for Dental Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
(a) Mounting: Recessed installation.
(b) Enclosures: Fabricated from minimum 1.2-mm-thick steel or minimum 1.27-mm-thick aluminum, with knockouts for electrical and piping connections.

5 Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for dental vacuum piping systems.

(a) Include alarm signals when the following conditions exist:
   i) Dental Vacuum: Vacuum drops below 18 kPa vacuum and backup vacuum pump is in operation.

6 Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for dental vacuum piping systems.

(a) Include alarm signals when the following condition exists:
   i) Dental Vacuum: Vacuum drops below 18 kPa vacuum.

9.2.6 Flexible Pipe Connectors

1 Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

(a) Working-Pressure Rating: 1725 kPa minimum.
(b) End Connections: Threaded copper pipe or plain-end copper tube.

9.2.7 Sleeves

1 Galvanized-Steel Sheet: 0.6-mm minimum thickness; round tube closed with welded longitudinal joint. Pipe Sleeve should be greater than pipe diameter by 1" for small pipe < 2" and double size for pipe > 2" according to steel schedule 10.

2 Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

(a) Under deck Clamp: Clamping ring with set screws.

9.2.8 Escutcheons

1 General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

2 One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

3 One-Piece, Cast-Brass Escutcheons: With set screw.

(a) Finish: Polished chrome-plated and rough brass.

4 Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
(a) Finish: Polished chrome-plated and rough brass.

5 One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

6 Split-Plate, Stamped-Steel Escutcheons: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

7 One-Piece, Floor-Plate Escutcheons: Cast iron.

8 Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

9.2.9 Grout

1 Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

   (a) Characteristics: Post-hardening, volume adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

   (b) Design Mix: 34.5-MPa, 28-day compressive strength.

   (c) Packaging: Premixed and factory packaged.

9.3 EXECUTION

9.3.1 Preparation

1 Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

   (a) Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

   (b) Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 0.453 kg of chemical to 11.3 L of water.

      i) Scrub to ensure complete cleaning.

      ii) Rinse with clean, hot water to remove cleaning solution.

9.3.2 Piping Applications

1 Connect new copper tubing to existing tubing with memory-metal couplings.

2 Dental Vacuum Piping: Use[ one of] the following piping materials for each size range:

   (a) DN 100 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
(b) DN 100 and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.

(c) DN 125 to DN 200: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

9.3.3 Piping Installation

1 Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

2 Comply with ASSE Standard #6010 for installation of vacuum piping.

3 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

4 Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

6 Install piping adjacent to equipment and specialties to allow service and maintenance.

7 Install vacuum and drain piping with 1 percent slope downward in direction of flow.

8 Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.

9 Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

10 Provide drain leg and drain trap at end of each main and branch and at low points.

11 Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

12 Install piping to permit valve servicing.

13 Install piping free of sags and bends.

14 Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
15 Install dental vacuum piping to dental vacuum service connections specified in this Section and to equipment specified in other Sections requiring dental vacuum service.

16 Install seismic restraints on vacuum piping.

17 Install dental vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

18 Install dental vacuum bottle bracket adjacent to each wall-mounted dental vacuum service connection suction inlet.

19 Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

20 Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

9.3.4 Valve Applications

1 Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

9.3.5 Valve Installation

1 Install shutoff valve at each connection to and from vacuum equipment and specialties.

2 Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.

3 Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

4 Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

5 Install safety valves on vacuum receivers, where required by HTM 02-01, and where recommended by specialty manufacturers.

6 Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.

7 Install flexible pipe connectors in suction inlet piping to each vacuum producer.

9.3.6 Joint Construction

1 Ream ends of pipes and tubes and remove burrs.

2 Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

3 Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4 Threaded Joints: Apply appropriate tape to external pipe threads.

5 Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

6 Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

7 Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by procedure manufacturer.

8 Flanged Joints:
   (a) Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

9 Pressure-Sealed Joints: Join copper tube and copper and copper-alloy fittings with tools recommended by fitting manufacturer.

10 Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

11 Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   (a) Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   (b) Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

9.3.7 Dental Vacuum Piping Alarm System Installation

1 Panels for dental vacuum piping systems may be combined in single panels with dental compressed-air piping systems and medical gas piping systems.

2 Install dental vacuum piping system alarm system components in locations required by and according to HTM 02-01.

3 Install dental vacuum piping system area and master alarm panels where indicated.

4 Install computer interface cabinet with connection to dental vacuum piping alarm system and to facility computer.

9.3.8 Sleeve Installation

1 Sleeves are not required for core-drilled holes.

2 Permanent sleeves are not required for holes formed by removable PE sleeves.
3 Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe

(a) Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
(b) Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 50 mm above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

4 Install sleeves in new walls and slabs as new walls and slabs are constructed.

5 Install sleeves that are large enough to provide 10-mm annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

(a) [Steel] Pipe Sleeves: For pipes smaller than DN 150
(b) Steel Sheet Sleeves: For pipes DN 150 and larger, penetrating gypsum board partitions.
   i) Seal space outside of sleeve fittings with grout.

6 Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials

9.3.9 Escutcheon Installation

1 Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

(a) New Piping:
   i) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   ii) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   iii) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
   iv) Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.
   v) Bare Piping in Equipment Rooms: One piece, stamped steel with spring clips

9.3.10 Hanger And Support Installation

1 Vertical Piping: MSS Type 8 or 42, clamps.

2 Individual, Straight, Horizontal Piping Runs:

(a) 30 m and Less: MSS Type 1, adjustable, steel, clevis hangers.
(b) Longer Than 30 m: MSS Type 43, adjustable, roller hangers.

3 Multiple, Straight, Horizontal Piping Runs 30 m or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4 Base of Vertical Piping: MSS Type 52, spring hangers.

5 Support horizontal piping within 300 mm of each fitting and coupling.

6 Rod diameter may be reduced 1 size for double-rod hangers, with 10-mm minimum rods.

7 Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   (a) DN 8 : 1500 mm with 10-mm rod.
   (b) DN 10 and DN 15 : 1800 mm with 10-mm rod.
   (c) DN 20 : 2100 mm with 10-mm rod.
   (d) DN 25 : 2400 mm with 10-mm rod.
   (e) DN 32 : 2700 mm with 10-mm rod.
   (f) DN 40 : 3 m with 10-mm rod.
   (g) DN 50 : 3.4 m with 10-mm rod.
   (h) DN 65 : 4 m with 13-mm rod.
   (i) DN 80 : 4.3 m with 13-mm rod.
   (j) DN 90 : 4.6 m with 13-mm rod.
   (k) DN 100 : 4.9 m with 13-mm rod.
   (l) DN 125 : 5.5 m with 13-mm rod.
   (m) DN 150 : 6 m with 16-mm rod.
   (n) DN 200 : 7 m with 19-mm rod.

8 Install supports for vertical copper tubing every 3 m.

9 Install[ vinyl-coated] hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   (a) DN 25 and Smaller: 760 mm with 10-mm rod.
   (b) DN 40 to DN 50: 900 mm with 10-mm rod.
   (c) DN 65 and DN 80 : 1150 mm with 13-mm rod.
   (d) DN 100 and DN 125 : 220 mm with 13-mm rod.
   (e) DN 150 and DN 200): 1350 mm with 16-mm rod.

10 Install supports for vertical PVC piping every 1220 mm.

9.3.11 Labeling And Identification

1 Install identifying labels and devices for laboratory vacuum piping, valves, and
specialties.

2 Install identifying labels and devices for dental vacuum piping systems according to HTM 02-01. Use the following or similar captions and color-coding for piping products where required by HTM 02-01:

9.3.12 Field Quality Control For Healthcare Facility Dental Vacuum Piping

1 Testing Agency: Engage a qualified testing agency to perform tests and inspections of dental vacuum piping systems in healthcare facilities and prepare test reports.

2 Perform tests and inspections of dental vacuum piping systems in healthcare facilities and prepare test reports.

3 Tests and Inspections:

(a) Dental vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of dental vacuum piping systems concurrently with tests, inspections, and certification of dental compressed-air piping systems.

(b) Perform the following Installer tests according to requirements in HTM 02-01 and ASSE Standard #6010:

   i) Initial blow down.
   ii) Initial pressure test.
   iii) Cross-connection test.
   iv) Piping purge test.
   v) Standing pressure test for vacuum systems.
   vi) Repair leaks and retest until no leaks exist.

(c) System Verification: Comply with requirements in HTM 02-01, ASSE Standard #6020, and ASSE Standard #6030 for verification of dental vacuum piping systems and perform the following tests and inspections:

   i) Standing pressure test.
   ii) Individual-pressurization or pressure-differential cross-connection test.
   iii) Valve test.
   iv) Master and area alarm tests.
   v) Piping purge test.
   vi) Final tie-in test.
   vii) Operational vacuum test.
   viii) Verify correct labeling of equipment and components.

(d) Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

   i) Inspections performed.
ii) Procedures, materials, and gases used.

iii) Test methods used.

iv) Results of tests.

4 Remove and replace components that do not pass tests and inspections and retest as specified above.

9.3.13 Demonstration

1 Train Owner's maintenance personnel to adjust, operate, and maintain dental vacuum alarm systems. Refer to Division 01 Section "Demonstration and Training."

10. VACUUM EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES

10.1 GENERAL

10.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General and Supplementary Conditions

10.1.2 Summary

1 Section Includes:

(a) Packaged, oil-sealed, rotary, sliding-vane vacuum pumps.

(b) Dental Vacuum Equipment alarm systems.

10.1.3 Definitions

1 Actual Air: Air delivered at vacuum producer inlet. Flow rate is air measured in expanded L/min.

2 Low Voltage: As defined for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

3 Dental Vacuum Equipment includes dental vacuum equipment and accessories for healthcare facilities.

4 Standard Air: Free air at 20 deg C and 29.92 in. Hg before compression or expansion and measured in standard L/min.

10.1.4 Performance Requirements

1 Delegated Design: Design vacuum equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2 Seismic Performance: Vacuum equipment shall withstand the effects of earthquake motions determined according to [SEI/ASCE 7].
The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

10.1.5 Submittals

1 Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   (a) Wiring Diagrams: For power, signal, and control wiring.

2 Delegated-Design Submittal: For vacuum-producing equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   (a) Detail fabrication and assembly of supports.
   (b) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3 Qualification Data: For qualified Installer [and] testing agency.

4 Seismic Qualification Certificates: For vacuum producers, accessories, and components, from manufacturer.
   (a) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   (b) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   (c) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

5 Field quality-control reports.

6 Operation and Maintenance Data: For vacuum equipment to include in operation and maintenance manuals.

10.1.6 Quality Assurance

1 Installer Qualifications:
   (a) Dental vacuum System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.

2 Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   (a) Qualify testing personnel according to ASSE 6020 for inspectors and
ASSE 6030 for verifiers.

3 Electrical Components, Devices, and Accessories: Listed and labeled as defined by a qualified testing agency, and marked for intended location and application.

4 ASME Compliance: Fabricate and label [receivers] [and] [separators] to comply with ASME Boiler and Pressure Vessel Code.

5 Comply with HTM 02-01, "Health Care Facilities," for vacuum equipment and accessories for dental vacuum systems.

6 Comply with UL 544, "Medical and Dental Equipment," for dental vacuum equipment.

10.1.7 Project Conditions

1 Interruption of Existing Dental vacuum Service(s): Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   (a) Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
   (b) Do not proceed with interruption of service without Owner’s written permission.

10.1.8 Coordination

1 Coordinate sizes and locations of concrete bases with actual equipment provided.

10.1.9 Extra Materials

1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   (a) Belts: Two for each belt-driven vacuum producer.

10.2 PRODUCTS

10.2.1 General Requirements For Packaged Vacuum Pumps (1 Package Simplex)

1 Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers.

2 Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
   (a) Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
   (b) Motor Controllers: Full-voltage, combination-magnetic type with under voltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
(c) Control Voltage: 120-V ac or less, using integral control power transformer.
(d) Motor Overload Protection: Overload relay in each phase.
(e) Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
(f) Automatic control switches to sequence lead-lag vacuum pumps for multiplex vacuum pumps.
(g) Instrumentation: Include vacuum pump inlet and receiver vacuum gages, hour meter, vacuum pump discharge-air and coolant temperature gages, and control transformer.
(h) Alarm Signal Device: For connection to alarm system to indicate when backup vacuum pump is operating.

3 Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.

(a) Interior Finish: Corrosion-resistant coating.
(b) Accessories: Include vacuum relief valve, vacuum gage, and drain.

4 Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

10.2.2 Oil-Sealed, Rotary, Sliding-Vane Vacuum Pumps

1 Description: one Simplex Packaged units

2 Vacuum Pumps: Non-pulsating, oil-sealed, rotary, sliding-vane type.

(a) Cleanable inlet screens.
(b) Outlet silencers and oil-mist separators on discharge connections.

3 Capacities and Characteristics:

4 Capacities and Characteristics per package:

5 For the Capacities and Characteristics:

6 For Al Shamal Site (Type C) refer To DWG No MG-50-601

10.2.3 Dental Vacuum Equipment Alarm Systems

1 General Requirements for Dental Vacuum Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by HTM 02-01 for alarm systems.

2 Components: Designed for continuous service and to operate on power supplied from 240V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

3 Vacuum Switches or Transducer Sensors: Continuous equipment monitoring with electrical connections for alarm system.
(a) Vacuum Switches: 0- to 101-kPa vacuum operating range.

4 General Requirements for Dental Vacuum Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

(a) Mounting: Recessed installation.

(b) Enclosures: Fabricated from minimum 1.2-mm- thick steel or minimum 1.27-mm- thick aluminum, with knockouts for electrical and piping connections.

5 Local and Master Alarm Panels: Separate trouble alarm signals and pressure gages to indicate function of Dental Vacuum Equipment when the following conditions exist:

(a) Dental vacuum Equipment: Drops below 25-kPa] vacuum, backup vacuum producer is in operation, and high water level is in receiver.

10.3 EXECUTION

10.3.1 Preparation

1 Clean vacuum equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for dental vacuum applications, according to CGA G4.1, "Cleaning Equipment for Oxygen Service."

10.3.2 Dental Vacuum Equipment Installation

1 Install vacuum equipment for healthcare facilities according to ASSE 6010 and HTM 02-01.


(a) Minimum Deflection: 6 mm.

(b) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 450-mm centers around the full perimeter of concrete base.

(c) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

(d) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

(e) Install anchor bolts to elevations required for proper attachment to supported equipment.

3 Equipment Mounting: Install vacuum producers using elastomeric pads]

(a) Minimum Deflection: 6 mm.

4 Equipment Mounting: Install vacuum producers on vibration isolation inertia bases.
5 Equipment Mounting: Install vacuum producers on concrete bases.

(a) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 450-mm centers around the full perimeter of concrete base.

(b) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

(c) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

(d) Install anchor bolts to elevations required for proper attachment to supported equipment.

6 Install vacuum equipment anchored to substrate.

7 Orient equipment so controls and devices are accessible for servicing.

8 Maintain manufacturer's recommended clearances for service and maintenance.

9 Install the following devices on vacuum equipment:

(a) Thermometer, Vacuum Gage, and Pressure Relief Valve: Install on each vacuum pump receiver.

(b) Drain Valves: Install on [receivers] [and] [separators]. Discharge receiver condensate over nearest floor drain. Discharge separator oral evacuation fluids by direct connection into sanitary waste piping system.

10.3.3 Dental Vacuum Equipment Alarm System Installation

1 Alarm panels for Dental Vacuum Equipment may be combined in single panels with medical air equipment and medical gas piping systems.

2 Install Dental Vacuum Equipment alarm system components in locations required by and according to HTM 02-01.

3 Install Dental Vacuum Equipment local and master alarm panels where indicated.

10.3.4 Computer Interface Cabinet Installation

1 Install computer interface cabinet with connection [to dental vacuum piping alarm system and] to facility computer.

10.3.5 Connections

1 Comply with requirements for water-supply piping Drawings indicate general arrangement of piping, fittings, and specialties.

2 Comply with requirements for drain piping Drawings indicate general arrangement of piping, fittings, and specialties.

3 Comply with requirements for vacuum piping Drawings indicate general arrangement of piping, fittings, and specialties.
4 Install piping adjacent to equipment to allow service and maintenance.

5 Connect vacuum piping to vacuum equipment, accessories, and specialties with shutoff valve and union or flanged connection.

6 Connect water supply to vacuum equipment that requires water. Include backflow preventer.

10.3.6 Identification

1 Identify nonmedical laboratory vacuum equipment system components.

2 Identify Dental Vacuum Equipment system components. Comply with HTM 02-01.

10.3.7 Field Quality Control For Healthcare-Facility Dental Vacuum Equipment

1 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

2 Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3 Perform tests and inspections.

(a) Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

4 Tests and Inspections:

(a) Dental Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of Dental Vacuum Equipment concurrently with tests, inspections, and certification of dental vacuum piping systems.

(b) Preparation: Perform Dental Vacuum Equipment tests according to requirements in HTM 02-01 for the following:

i) System operation test.

(c) Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and HTM 02-01 for verification of dental vacuum equipment.

(d) Replace damaged and malfunctioning controls and equipment.

(e) Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

i) Inspections performed.

ii) Procedures and materials used.

iii) Test methods used.

iv) Results of tests.
5 Components will be considered defective if they do not pass tests and inspections.

6 Prepare test and inspection reports.

10.3.8 Startup Service

1 Engage a factory-authorized service representative to perform startup service.

(a) Complete installation and startup checks according to manufacturer's written instructions.

(b) Check for lubricating oil in lubricated-type equipment.

(c) Check belt drives for proper tension.

(d) Verify that vacuum producer outlet piping is clear.

(e) Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.

(f) Check safety valves for correct settings.

(g) Check for proper seismic restraints.

(h) Drain [receiver] [and] [separator] tank(s).

(i) Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

(j) Test and adjust controls and safeties.

2 Verify that vacuum equipment is installed and connected according to the Contract Documents.

3 Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.

4 Prepare written report documenting testing procedures and results.

10.3.9 Demonstration

1 Train Owner's maintenance personnel to adjust, operate, and maintain vacuum producers.
11. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

11.1 GENERAL

11.1.1 Related Documents

1 Drawings and General Provisions of Contract, including General Conditions, Conditions of Particular Applications apply to work of this Section.

11.1.2 Related Sections

1 Separate electrical components and materials required for field installations and electrical connections are specified in Electrical Specs.

11.1.3 Summary

1 This section specifies the basic requirements for electrical components, which are an integral part of packaged mechanical equipment. These components include, but are not limited to, factory installed motors, starters, disconnect switches furnished as an integral part of packaged mechanical equipment.

2 Specific electrical requirements (i.e. kilowatt and electrical characteristics) for mechanical equipment are specified within the individual equipment specification sections.

11.1.4 Submittals

1 No separate submittal is required. Submit product data for motors, starters and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification section.

11.2 PRODUCTS

11.2.1 Motors

1 The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

(a) Torque Characteristics: Shall be sufficient to satisfactorily accelerate the driven loads.

(b) Motor Sizes: Shall be large enough so that the driven load will not require the motor to operate in the service factor range.

(c) Temperature Rating: Rated for 50°C environments with maximum 110°C temperature rise for continuous duty at full load.

(d) Starting Capability: Frequency of starts as indicated by automatic control system and not less than 5 evenly time spaced starts per hour for manually controlled motors.

(e) Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
11.2.2 Bearings

1. Ball or roller bearings with inner and outer shaft seals;
2. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance;
3. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor;
4. For fractional horsepower, light duty motors, sleeve type bearings are permitted.

11.2.3 Enclosure Type

1. Guarded drip-proof motors IP 54.

11.2.4 Noise Rating

1. "Quiet"

11.2.5 Efficiency

1. "Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEC Standards. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEC Standards.

11.2.6 Nameplate

1. Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

11.2.7 Starters, Electrical Devices and Wiring

1. Motor Starter Characteristics: Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
3. Magnetic Starters: Maintained contact push buttons and pilot lights, properly arranged for operation as indicated.
4. Trip-free thermal overload relays, each phase.
5. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements.
7. Under-voltage release or protection.
8. Motor Connections: Flexible conduit, except where plug-in electrical cords are specifically indicated.
9 Capacitors:

(a) Features:
   i) Individual unit cells.
   ii) All welded steel housing.
   iii) Each capacitor internally fused.
   iv) Non-flammable synthetic liquid impregnate.
   v) Craft tissue insulation.
   vi) Aluminum foil electrodes.

10 KVAR size shall be as required to correct motor power factor to 90% or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor at rated load.

11 Disconnect Switches:

   (a) Fusible Switches: Fused, each phase; general duty; horsepower rated; non-teasable quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.

   (b) Non-fusible Switches: For equipment motor 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type (Item 2.7.5.1).

12 Enclosures: Enclosures for electrical equipment shall be of IP 54 to IEC Standards.

11.3 EXECUTION

(Not Applicable)
12. BASIC MECHANICAL MATERIALS AND METHODS

12.1 GENERAL

12.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General Conditions, Conditions of Particular Application apply to this Section.

12.1.2 Summary

1 This section includes the following basic mechanical materials and methods to complement other Plumbing Sections.

(a) Piping materials and installation instructions common to most piping systems.
(b) Concrete equipment base construction requirements.
(c) Equipment nameplate data requirements.
(d) Non-shrink grout for equipment installations.
(e) Field-fabricated metal.
(f) Installation requirements common to equipment specification sections.
(g) Cutting and patching.
(h) Touchup painting and finishing

2 Pipe and pipe fitting materials as specified in piping system Sections.

12.1.3 Definitions

1 Pipe, Pipe Fittings and Piping: Include tube, tube fittings, and tubing.

2 Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

3 Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

4 Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

5 Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

6 Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
12.1.4 Submittals

1 Submit the following according to the Conditions of the Contract and all Specification Sections:

2 Product data: for the following piping specialties:
   (a) Mechanical sleeve seals.
   (b) Identification materials and devices.

3 Samples: of color, lettering style, and other graphic representation required for each identification material and device.

4 Shop Drawings: detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

5 Coordination Drawings: for access panel and door locations.

6 Prepare Coordination Drawings: "Submittals" to 1:50 scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:
   (a) Proposed locations of piping, ductwork, equipment, and materials. Include the following:
      (i) Planned piping layout, including valve and specialty locations and valve stem movement.
      (ii) Planned duct systems layout, including elbow radii and duct accessories.
   (b) Clearances for installing and maintaining insulation
   (c) Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
   (d) Equipment service connections and support details.
   (e) Exterior wall and foundation penetrations.
   (f) Sizes and location of required concrete pads and bases.

7 Floor Plans, Elevations, and Details: to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

8 Welder Certificates: signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

12.1.5 Quality Assurance

1 Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code-Steel".

2 Qualify welding processes and operators for piping according to ASME "Boiler
3 Comply with provisions of AMSE B31 Series "Code for Pressure Piping"

4 Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

5 Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

6 Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

12.1.6 Delivery Storage and Handling

1 Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, and moisture. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor. Protect flanges, fittings and piping specialties from moisture and dirt. Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

12.1.7 Sequencing and Scheduling

1 Coordinate mechanical equipment installation with other building components. Arrange for chases, slots and openings in building structure during progress of construction to allow for mechanical installations. Coordinate the installation of required supporting devices and set sleeves in concrete and other structural components. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate connection of electrical services.

2 Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations. Mechanical items requiring access are concealed behind finished surfaces. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces.

12.2 PRODUCTS

12.2.1 Pipe and Pipe Fittings

1 Refer to individual piping system specification in Plumbing Specs, Sections for pipe and fitting materials and jointing methods.

12.2.2 Jointing Materials

1 Refer to individual piping system specification Sections in Plumbing Specs for
special jointing materials not listed below.

2 Pipe Flange Gasket Materials: Suitable for the chemical and thermal condition of the piping system contents.

3 ASME B16.21, nonmetallic, flat, asbestos-free, 3 mm maximum thickness, except where thickness or specific material is indicated.
   (a) Full-Face Type: For flat-face, Class 125 cast-iron.
   (b) Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.

4 ASME B16.20 for grooved, ring-joint, steel flanges.

5 AWWA C100, rubber, flat face, 3 mm thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

6 Flange Bolts and Nuts: ASME B18=8.2.1, carbon steel, except where other materials is indicated.

7 Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

8 Flanged, Ductile-Iron pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

9 Couplings: Cast iron body sleeve assembly, fabricated to match outside diameters of plain-end pressure pipes (for buried piping).
   (a) Sleeve: ASTM A 126, Class B, gray iron.
   (b) Followers: ASTM A 47 (ASTM A 47 M), grade 32510 or ASTM A 536 ductile iron.
   (c) Gaskets: Rubber.
   (d) Bolts and Nuts: AWWA C1110.
   (e) Finish: Enamel paint.

12.2.3 Piping Specialties

1 Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves. The inside diameter shall closely fit around pipe, tube, and insulation, the outside diameter shall completely cover opening.

2 Stamped Steel: One-piece, with set-screw or split plate, with concealed hinge, spring clips and chrome-plated finish.

3 Finished spaces where polished chrome plate finish shall be used.

4 Cast-Iron Floor Plate: One-piece casting.

5 Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion. Provide
combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials with insulating materials suitable for system fluid, pressure, and temperature.

6 Dielectric Unions: Factory-fabricated, union assembly for 1000 kPa minimum working pressure at a 107 °C temperature.

7 Dielectric Flanges: Factory-fabricated, companion-flange assembly for 1000 kPa minimum pressure or to suit system pressures.

8 Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Provide separate companion flanges and steel bolts and nuts for 1000 kPa minimum working pressure or to suit system pressures.

9 Dielectric Couplings: Galvanized-steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends for 1000 kPa minimum working pressure at 107 °C temperature.

10 Dielectric Nipples: Electroplated steel nipple, having inert and noncorrosive thermoplastic lining, with combination of plain threaded, or grooved end types for 1000 kPa working pressure at 107 °C temperature.

11 Mechanical Sleeve Seals: Modular, watertight mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.

12 Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

13 Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.

14 Cast-Iron: Cast or fabricated wall pipe equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.

15 Underground Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C 110 and 1 plain pipe-sleeve end.

(a) Penetrating Pipe Deflection: 5 percent without leakage.

(b) Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.

(c) Pipe Sleeve: AWWA C151, ductile-iron pipe.

(d) Housing-to-Sleeve Gasket: Rubber or neoprene push-on type of manufacturer's design.

12.2.4 Identifying Devices and Labels

1 General: Manufacturer's standard products of categories and types required for
each application as referenced in other Plumbing Sections. Where more than one type is specified for listed application, submit for the Engineer’s approval single selection for each product category.

2 Equipment Nameplates: Metal nameplate with operational data engraved or stamped, permanently fastened to equipment.

3 Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.

4 Location: An accessible and visible location.

5 Stencils: Standard stencils, prepared for required applications with letter sizes conforming to recommendations of ASME A 13.1 for piping and similar applications, but not less than 30 mm-high letters for ductwork and not less than 19 mm high letters for access door signs and similar operational. Provide fiberboard material with standard exterior type stenciling enamel paint; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.

6 Provide standard identification enamel paint of colors indicated or, if not otherwise indicated for piping systems, comply with ASME A 13.1 for colors.


8 Pressure-Sensitive Pipe Markers: Manufacturer’s standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, conforming to ASME A 13.1.

9 Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface black phenolic core, with white (letter color) melamine subcore, except when other color are indicated. Fabricate in size required for message, engraved with engraver’s standard letter style, of sizes and with wording to match equipment identification. Punch for mechanical fastening. Provide 1.5 mm thick for units up to 13 000 mm2 or 200 mm long; 3 mm for larger units with self- tapping stainless-steel screws or contact-type permanent adhesive.

10 Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment. Where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as “Boiler No. 3”, “Pump No. P1”, or “Fire Cabinet FC”.

12.2.5 Grout

1 Non-shrink, Nonmetallic Grout, ASTM C 1107, Grade B. Post- hardening, volume-adjusting, dry, hydraulic-cement grout, non-sustaining, non-corrosive, nongaseous, and recommended for interior and exterior applications. Design mix
of 34.50 MPa, 28-days compressive strength, premixed and factory-packaged.

12.3 EXECUTION

12.3.1 Piping System-Common Requirements

1 General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specified Sections in Plumbing Specs specify piping installation requirements unique to the piping system.

2 General Locations and Arrangements: The Contract Drawings indicate various piping systems schematically. No added compensation shall be permitted for variations due to field conditions.

3 Examine, carefully, the Architectural, Structural, Fire Protection, Heating, Ventilation, Air Conditioning, Electrical and Interior Drawings to avoid possible installation conflicts.

4 Examine substrates and conditions under which systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

5 Submit to the Engineer Shop Drawings covering scope of works. No work shall be carried out until the shop drawings have been approved by the Engineer. Reproduction of Contract Drawings by the Contractor shall not be acceptable as Shop Drawings.

6 Be responsible for the proper installation of complete systems.

7 Where equipment furnished differs in physical character from that specified and/or indicated, or requires increased services and/or facilities to be provided by other trades and such equipment is acceptable to the Engineer, then pay and bear all costs of modifying the substituted items to fit the conditions indicated or the costs of modifying the building to properly receive the item.

8 Make, without additional cost to the Employer, any change from the Drawing necessary to make the work conform to the site as constructed and/or to fit the work of other trades, or to conform to any and all prevailing rule changes.

9 Check the layout of the piping, equipment fixtures, etc. and determine the exact locations by dimensions of the approved material.

10 Furnish sleeves for passage of pipes through structural masonry and concrete walls, floors and elsewhere as shall be required for the protection of each piping passing through building elements.

11 Provide required supports and hangers for piping and equipment, so loading will not exceed allowable loadings of structure.

12 Install piping at indicated and/or required slope. Install components having pressure rating equal to or greater than system operating pressure. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas. Install piping free of sags and bends. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are
prohibited, except where indicated. Install piping tight to slabs, beams, joists, columns, walls and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal. Install piping to allow application of insulation plus 25 mm clearance around insulation. Locate groups of pipes parallel to each other, spaced to permit valves servicing. Install fittings for changes in direction and branch connections. Install couplings according to manufacturer's printed instructions.

13 Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, concrete floor and roof slabs, and where indicated.

14 Cut sleeves to length for mounting flush with both surfaces.

15 Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 50 mm above finished floor level. Extend cast iron sleeve fittings below floor slab as required to secure clamping ring where specified. Build sleeves into new walls and slabs as work progresses. Install large enough sleeves to provide 6 mm annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

16 For floors having membrane waterproofing, provide cast-iron sleeve fitting.

17 Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 50 mm above finished floor level. Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.

18 Except for below-grade wall penetration seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in specs of "Joint Sealants".

19 For above grade, exterior wall pipe penetrations, seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 25 mm annular clear space between pipe and sleeve for installation of mechanical seals. Assemble and install mechanical seals according to manufacturer's printed instructions.

20 For below grade, exterior wall pipe penetrations, install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 25 mm annular clear space between pipe and sleeve for installation of mechanical seals.

21 Verify: final equipment locations for roughing in. Refer to equipment specifications in other Sections for roughing-in requirements.

22 Piping Joint Constructions: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

23 Ream ends of pipes and tubes and remove burs. Bevel plain ends of steel pipe. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

24 Threaded Joints: Thread pipe with tapered pipe threads to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
(a) Note the internal length of threads in fittings or valve and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

(b) Apply appropriate tape or thread compound to external pipe threads.

(c) Align threads at point of assembly.

(d) Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.

(e) Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.


26 Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanged and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

27 Piping Connections: Except as otherwise indicated, make piping connections as specified below.

28 Install unions in piping 50 mm and smaller adjacent to each valve and at final connection to each piece of equipment having a 50 mm or smaller threaded pipe connection.

29 Install flanges in piping 65 mm and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

12.3.2 Equipment Installation-Common Requirements

1 Install equipment to provide the maximum possible headroom where mounting heights are not indicated. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer for conflicts to the Engineer. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

2 Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting with minimum of interference with other installation. Extend grease fittings to an accessible location.

3 Install equipment giving right-of-way to piping systems installed at a required slope.

12.3.3 Labeling and Identifying

1 Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow. Use plastic markers with application systems. Install on
pipe insulation segment where required for hot non-insulated pipes.

2 Locate pipe markers wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), and exposed exterior locations as follows:

(a) Near each valve and control device.
(b) Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
(c) Near locations where pipe pass through walls, floors, ceilings, or enter inaccessible enclosures.
(d) At access doors, manholes, and similar access points that permit view of concealed piping.
(e) Near major equipment items and other points of origination and termination.
(f) Spaced at a maximum of 15 m intervals along each run. Reduce intervals to 7.5 m in congested areas of piping and equipment.
(g) On piping above removable acoustical sign or equipment omit immediately spaced markers.

3 Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.

4 Lettering Size: Minimum 6 mm high lettering for name of unit where viewing distance is less than 0.6 m, 13 mm high for distances up to 1.8 m and proportionately larger than lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

5 Test of Signs: Provide test to distinguish between multiple units, inform operator of operational requirements, indicated safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.

12.3.4 Painting and Finishing

1 Refer to "Painting Specs" for field painting requirements.

2 Damage and Touch-Up: Repair marred and damaged factory-painted finishes with approved materials and procedures to match original factory finish.

12.3.5 Concrete Bases

1 Construct concrete equipment bases of dimensions indicated, but not less than 100 mm larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use Grade C, 28-day compressive strength concrete and reinforcement as specified in "Concrete and Reinforced Concrete" Specs.

12.3.6 Erection of Metal Supports and Anchors

1 Cut, fit and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
12.3.7 Cutting and Patching

1 Cut, channel, chase and drill floors, walls, partitions, ceilings and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.

12.3.8 Grouting

1 Install nonmetallic non-shrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions. Clean surfaces that will come into contact with grout. Provide forms for placement of grout, as required. Avoid air entrapment when placing grout. Place grout to completely fill equipment bases, on concrete bases to provide a smooth bearing surface for equipment, around anchors and according to manufacturer's printed instructions.

12.3.9 Installation of Storage Tanks and Water Heaters

1 Install tanks plumb level in accordance with manufacturer's installation instructions, and firmly anchored in location maintaining manufacturer's recommended clearance.

2 Install piping adjacent to storage tanks to allow for servicing and maintenance. Install thermometers and pressure gauges on water storage tanks, heaters and piping. Connect water piping to the tanks using unions or flanges and valves. Connect tank drains indirectly with valves and discharge over nearest floor drain. Use gate or ball valves for valves 50 mm and smaller, gate or butterfly valves for valves 65 mm and larger. Use dielectric fittings or dielectric union for connecting dissimilar metal. Install temperature and pressure relief valve.

3 Give particular attention to the supports and anchors for storage tanks to withstand the anticipated loads including seismic loads. Submit supporting details for the Engineer's approval.
13. COPPER TUBE AND FITTINGS

13.1 GENERAL

13.1.1 Related Documents

1. Drawings and general provisions of the Contract, including General Conditions, Conditions of Particular Application apply to work of this section.

13.1.2 Description of Work

1. This section specifies copper tube and fittings as required by the Contract.

2. Extent of copper tube and fittings is indicated on Drawings.

13.1.3 Reference Standards

1. Unless otherwise more stringent requirements are specified throughout this section, copper tube and fittings shall comply with the stipulations of the latest edition of the specifications of the British Standards (BS) or other equivalent international standards and Sound Practice, moreover the requirements of the Qatar Construction specification rules and regulations guide for plumbing and drainage works.

2. British Standards

   (a) BS No.

      (i) 1172, Part 1

      (ii) 6700

      (iii) 864: Part 1, Type B

13.1.4 Submittals

1. Submit the following in accordance with Conditions of the Contract and all Specification Sections:

   (a) Materials specifications and manufacturer's data

   (b) Certificates of compliance

   (c) Installation structure and method of jointing

   (d) Representative samples of tube, fittings and accessories to be used in the work

   (e) Shop drawings

13.1.5 Quality Assurance

1. Inspection and Test by the Manufacturer: Tube and fittings shall be thoroughly inspected by the manufacturer before delivery. The manufacturer shall make all tests as specified in referenced standards and the results of the tests shall be furnished to the Contractor upon request in accordance with mutually acceptable
arrangements. The manufacturer may use his own or other suitable facilities for the performance of the inspection and test requirements specified herein.

2 Testing: Materials and installed work may require testing and retesting at any time during the progress of the works. Tests, including retesting of rejected materials or installed Works, shall be done at the Contractor’s expense.

13.1.6 Delivery, Storage and Handling

1 Handle pipes and fittings so as to prevent injury or damage to them. Place no pipe or other material inside any other pipe at any time.

2 Prevent pipe end damage and prevent entrance of dirt or debris.

13.1.7 Related Sections

1 The following sections include requirements which relate to this section:
   (a) Basic Mechanical Materials and Methods
   (b) Hangers and Supports
   (c) Mechanical Insulation
   (d) Plumbing Works

13.2 PRODUCTS

13.2.1 Materials

1 Copper Tubes: Shall be seamless tubes produced by a continuous periphery in all stages of operations conforming to the requirements of BS 1172.

2 Copper tubes shall be drawn temper, Table Y for underground installations with a coating of seamless continuous PVC sheeting and be drawn temper, Table X for above ground installations. Dimensions, weights, tolerances in diameter and wall thicknesses shall conform to the requirements of BS 2871 Part 1.

3 Copper tubes shall be in the form of straight lengths.

4 Rating: Installed copper tubes and fittings shall withstand the following minimum pressure rating:

5 Working Pressure: 850 kPa

6 Test Pressure: 1 200 kPa

7 Fittings
   (a) Pipe Threads for Tubes and Fittings (parallel threads): BS 2779
   (b) Pipe Threads for Tubes and Fittings (taper threads): BS 21
   (c) Bronze Flanges and Flanged Fittings: ANSI B 16.24 to be complied with valve flanges and control device flanges
(d) Copper Unions: Cast bronze joint pressure fitting, hexagonal stock with ball and socket joint, metal to metal seating surfaces and solder-joint threaded or solder-joint and threaded ends.

(e) Mechanically formed outlets may be used and shall be manufacturer's standard procedure for forming tee-branch outlet from tube performed with proper tools. Use integral solder ring fittings for piping size 50 mm and smaller.

13.3 EXECUTION

13.3.1 Installation, General

Installation of copper tube and fittings shall comply with requirements Section 19 Part 12 "Plumbing Works" for installation inside buildings.

13.3.2 Joint Construction

1 Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual".

2 Measure the length of tube accurately to insure joint quality. Cut the tube to exact length to a square cut using tube cutters, hacksaw blade or abrasive saw. Ream the end of the tube to remove burrs, and when hacksaw is used, to remove both burrs and silvers. Straighten the pipe by sizing tool to bring the tube end to true dimension and roundness should it be out of round while cutting. Clean the surfaces to be jointed from oil, grease and heavy oxide. Use fine sand cloth (00), cleaning pad or special wire brushes. Rub hard enough to remove surface film or soil but not hard enough to remove metal. Ensure that particles of material do not fall into the tube or fitting. Clean the end of the tube for a distance only slightly more than is required to enter the socket of the fitting. Similarly clean sockets of fittings. Apply with a small brush or clean rag a thin film of flux, as soon as possible after cleaning, on the surface to be jointed. Ensure that flux shall be stirred when a new can is opened or an opened can has been standing more than a few hours. Exercise particular care to avoid leaving excess flux inside the completed joint. Assemble the joint by inserting the tube into fitting socket. Make sure that the tube is firmly against the end of the socket. Apply a small twist to help flux spread over the two surfaces. Remove the excess flux with a rag. Ensure that assembled joints be soldered, as soon as possible after applying flux, but not after one and one half hour. Never leave fluxed assembled joint overnight without soldering. Apply heat with a propane or butane torch or with air-acetylene or an oxy-acetylene torch. Do not point the flame into the socket, avoid overheating in order not to burn the flux and destroy its effectiveness. Open, reclean and reflux the joint if the flux has been burned. Avoid over-heating cast fittings. Apply solder, when the joint is hot enough, to melt on contact with the tube and the flame should be moved away. Remove solder if it does not melt, continue to heat, then try again. Make joints in subassemblies, whenever possible, in a vertical position before installation. For joining copper tube to solder cup valves, follow manufacturer's instructions. Valves should be in full open position before applying heat and the heat shall be applied to the tube only. Allow joint to cool natural for some time when cast fittings are used to avoid cracks. Examine the entire assembles, when completed, by turning on the water. There should be no leaks. Drain the line, if a leak is discovered, reheat the joint and repair.
13.3.3 Protection

1 For underground pipes two layers, overlapped 50%, of approved tape as recommended by manufacturer to be compatible with pipe material. Inner layer shall be minimum 500 microns thick and 100 mm wide. Outer layer shall be 750 microns thick and 100 mm wide.

2 All underground pipe work and buried pipe work in floor slabs and concealed pipe work inside wall chases if any shall be in copper tube to BS 2871 - Part 1, Table 'Y' covered in factory bonded green colour polyethylene sleeve. Fittings shall be to BS 864 - Part 2 Type 'B'.

13.3.4 Testing

Installed copper tubes shall be tested in accordance with the requirements of Section 19 Part "Plumbing Works" for installation inside buildings.
14. POLYPROPYLENE PIPES AND FITTINGS

14.1 GENERAL

14.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General Conditions and Conditions of Particular Application, apply to this Section.

14.1.2 Description of Work

1 PP Chemical waste / Sewarage Drainage and Vent Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion joint ends.

14.1.3 Related Sections

1 The work of polypropylene pipes and fittings shall conform to the stipulations of the latest edition of the international standards.

2 DIN 8077/78 Polypropylene (PP-R80) Pipes, Fiber sheeted PN 10, for cold water

3 DIN 8077/78 Polypropylene (PP) Pipes, Fiber sheeted PN 20 for hot water

4 DIN 8077/78 Pipe Joints Assemblies and PN 10 for risers with UV – protective layer (black layer).

5 Div19650 Polypropylene pipes for drainage system for restaurants and food courts

14.1.4 Submittals

1 Submit the following in accordance with Conditions of the Contract

(a) Materials list and manufacturer’s data

(b) Certificates of compliance

(c) Representative samples of pipes, fittings and accessories to be used in the work

(d) Shop drawings

(e) Installation structure and method of jointing

(f) Post-installation test procedures

(g) Maintenance data
14.1.5 Quality Assurance

1 Inspection and Test by the Manufacturer: Pipe and fittings shall be thoroughly inspected by the manufacturer before delivery. The manufacturer shall make all tests as specified herein and the results of the tests shall be furnished to the contractor upon request in accordance with mutually acceptable arrangement. The manufacturer may use his own or other suitable facilities for the performance of the inspection and test requirements specified herein. On the sample pieces selected for inspection, the inside diameter of the spigot end shall be checked by suitable gauges. Fittings shall be suitably inspected for soundness and brittleness.

2 Certification: The Contractor shall submit to the Engineer, prior to the delivery of goods, the conformance certification of the manufacturer, test results or copies of test reports which include specific gravity, coefficient of linear expansion, thermal conductivity at 90°C, specific heat, softening water absorption, point vicat, maximum continuous temperature rating, tensile strength, resistance limit under constant load, modulus of elasticity, flexural strength, compressive strength, elongation at break, flame retardant and other required test reports.

14.1.6 Delivery, Storage and Handling

1 Care shall be exercised in handling, loading, transporting, unloading and storing pipes and fittings to avoid distribution, scratches, gouges, dents and particular scuffing of the ends. Pipes shall be transported in a vehicle having a bed long enough to provide support for the full length of the pipe. Pipe or fitting that has been damaged or distorted shall be replaced. Pipes and fittings shall be stored under cover in a flat horizontal position to prevent sagging or bending and protected from direct sunlight and harmful soil elements until ready for installation.

2 Place no pipe or other material inside any other pipe at any time.

14.1.7 Related Sections

1 The following sections include requirements which relate to this section:

(a) Plumbing Works
(b) Hangers and Supports

14.2 PRODUCTS

14.2.1 Pipe, Fittings and Accessories

1 General: Pipe, fittings and accessories shall be produced from a material substantially consisting of polypropylene. Only those additives that are needed may be used for the manufacture of the polymer and for its conversion into sound, durable extrusions or mouldings of good surface finish, mechanical strength and opacity.

2 Pipes and fittings shall be of soldered or screwed type joints and flanged with flange adaptors.
3 Exposed PP Pipes and Risers shall be coated by black layer polyethylene.

4 Material: Polypropylene random-copolymerisate of high molecular weight and stabilized to high temperature.

5 Operating Pressure: The regulations and guide-lines-dealing with the different fields of application are to be observed.

6 Physical Characteristics

(a) General Properties and Appearances: Pipes shall be reasonably round, homogenous throughout, free from voids, cracks and other defects that would impair the performance in service; and as uniform as commercially practical in colour, density and other physical properties.

(b) Pipe surface shall be free from nicks, scratches and other blemishes. The joining surfaces of pipe shall be free from gauges and other imperfections that may cause leakage at joints.

(c) The internal and external surfaces of pipe shall be smooth, clean and reasonably free from grooving and other defects. Pipes shall be reasonably straight.

7 Marking: Pipes shall be indelibly marked. In no case shall mark intervals exceed 3 m. Pipe markings shall continuously include the following:

(a) Manufacturer's name
(b) Nominal size
(c) Identification code
(d) All fittings shall be marked on the body on hub on both sides. The marking shall, at least consist of the manufacturer's name or trace mark or both.

14.2.2 Jointing

1 Fusion jointing by heat welding as per installation requirements and manufacturer's recommendations.

14.3 EXECUTION

14.3.1 General

1 Conform to “Plumbing Works” and the manufacturer's recommendations.

14.3.2 Preparation for the fusion

1 Cut the pipe at right angles to the pipe axis.

2 Take care that the pipe axis is free from burrs or cutting chips and remove if necessary.

3 Mark the welding depth at the end of the pipe

4 Mark the desired position of the fitting on the pipe and/or fitting.
14.3.3  Fusion Weld Jointing

1. Push the end of the pipe, without turning, up to the marked welding depth into the welding tool.

2. At the same time push the fitting, without turning, right down to the welding tool.

3. It is essential to observe the recommended heating times.

4. The heating time starts, when pipe and fitting have been pushed to the correct welding depth on the welding tool.

5. After the stipulated heating time quickly remove pipe and fitting from the welding tools. Join them immediately, and without turning, until the marked welding depth is covered by the bead of PP from the fitting.

6. Do not push the pipe too far into the fitting, as this would reduce the bore and in an extreme case close the pipe.

7. After the cooling period the fused joint is ready for use.

8. Immediately before welding take the electric welding socket out of the protective packing.

9. If the electric socket should be dirty, because clean its inner surface with non-grease alcohol. Use only lintfree, clean linen or cotton cloths (no synthetic fibre). Do not touch the welding surfaces of pipe and electric sockets after their cleaning.

10. In order to avoid that the pipe has not been put deep enough into the welding socket, it is recommended to mark the welding depth.

11. Put both pipe ends completely into the electric welding socket. Ensure that the pipes are squarly put into the electric welding socket and that the pipe ends cannot slip out.

12. Connect the plugs of the device with the electric welding socket.

14.3.4  Piping Installation

1. Piping Inside the Building:
   (a) Install piping next to equipment, accessories, and specialties to allow service and maintenance.
   (b) Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
   (c) Flanges may be used on aboveground piping unless otherwise indicated.
   (d) Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   (e) Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
(f) Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

(g) Install piping at indicated slopes.

(h) Install piping free of sags and bends.

(i) Install fittings for changes in direction and branch connections.

(j) Verify final equipment locations for roughing-in.

(k) Install sleeves for piping penetrations of walls, ceilings, and floors.

(l) Install sleeve seals for piping penetrations of concrete walls and slabs

(m) Install escutcheons for piping penetrations of walls, ceilings, and floors.

14.3.5 Piping Specialty Installation

1 Embed floor drains in 4-inch (100-mm) minimum depth of concrete around bottom and sides.

2 Fasten grates to drains if indicated.

3 Set floor drains with tops flush with pavement surface.

4 Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

5 Set cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep.

14.3.6 Hanger and Support Installation

1 Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.

2 Support vertical piping and tubing at base and at each floor.

3 Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch (10 mm).

4 Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

   (a) Spacing for PP piping is based on 180 deg F (82 deg C) maximum.

   (b) NPS 2 (DN 50): 33 inches (840 mm) with 3/8-inch (10-mm) rod.

   (c) NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.

   (d) NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.

   (e) NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.

   (f) NPS 8 (DN 200): 48 inches (1220 mm) with 7/8-inch (22-mm) rod.
5 Install supports for vertical PP piping every 72 inches (1830 mm).

6 Support piping and tubing not listed above according to MSS SP-69.

14.3.7 Piping Schedule

1 Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.

2 Single-Wall, Chemical-Waste Sewerage and Vent Piping for above and underground application: Use the following piping materials for each size range:

   (a) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PP drainage pipe and fittings and electrofusion joints.

   (b) NPS 6 (DN 150): PP drainage pipe and fittings and electrofusion joints.

   (c) NPS 8 to NPS 12 (DN 200 to DN 300): PP drainage pipe and fittings and electrofusion joints.

14.3.8 Pipe Accessories

1 Pipe Accessories to be same size as pipe run.

2 Pipe Unions on threaded pipes 50 mm diameter and under to have female threaded ends and ground metal to metal seats. Unions to be of same manufacturer, pressure class and material as other pipe fittings.

3 Dielectric Insulated Unions and Flanges to be suitable for temperature, pressure and all other operating conditions of service on which used. Dielectric insulated flanges to have insulating gaskets between flanges and Teflon sleeves and washers between bolts and nuts and the flanges.

4 Hangers and Supports: submit drawings for approval.

5 Hangers and Supports are to allow adjustment of slope of piping and removal without dismantling pipes.

6 Hangers and Supports to be designed and tested to sustain load 8 times actual supported load.

7 Hangers and Supports to be hot dipped galvanized steel with smooth flat bearing surfaces, to carry weight of piping and contents without sagging, swaying, vibrating or deforming, and allowing free movement of pipes due to expansion and contraction without noise or damage to piping or construction.

8 Hangers and Supports to be complete with all necessary structural steel, rods, bolts, nuts, turnbuckles and other components.

9 Pipe Anchors and Guides: 20 mm diameter U-bolts to fit around pipe loosely for guides and welded to pipe for anchors.
14.3.9 Pipework

1 Install pipework in accordance with best engineering practice to present a neat, pleasing appearance. Vertical pipes to be plumb and horizontal pipes pitched up in direction of flow to allow proper venting and drainage.

2 Group pipes together where practicable and run in straight parallel lines close and parallel to walls, ceilings and columns.

3 Clearance: leave adequate clearance between pipes and adjacent pipes, walls, ceilings and columns for making joints properly, easy installation and revalves and accessories and proper installation of insulation and individual pipe hangers and supports.

4 Accessibility: install concealed piping to permit easy accessibility for maintenance and repair, particularly of valves, vents, drains and other accessories.

5 Expansion and Contraction: install piping to permit free expansion and contraction without damage to piping or structure. Provide adequate offsets and changes of direction to accomplish this.

6 Expansion and Contraction: where pipe loops or changes in direction cannot be employed to absorb thermal movement provide expansion joints and pipe anchors and guides.

7 Joints: cut pipes square and to exact length with a hacksaw. Ream cut end with a special tool to full inside diameter and remove chips.

8 Threaded Joints: Where needed, threads to be cut to British Standard Taper Pipe Thread. Cut threads with new dies and remove burrs and chips with wire brush.

9 Threaded Joints: make up tight close to shoulder of male thread. Use Teflon tape, thread sealant or other approved special jointing compound.

10 Flanged Joints: Where needed, make perfectly square with pipe, fit with rings gaskets and assemble with steel square head machine bolts and hexagonal nuts.

11 Unions Or Flanges: provide at connections to equipment, near valves, controls, strainers and other accessories requiring removal.

12 Expansion Joints: when used give consideration to anchoring and guiding pipes for controlled expansion and contraction. Follow instructions of manufacturer.

13 Joints Between Dissimilar Metals: make through dielectric insulated unions and flanges. Use unions on threaded piping and flanges on welded piping.

14 Fittings: changes in direction and size, branching and jointing of pipes are to be made with regular pipe fittings. Do not bend pipe.

15 Fittings: field fabricated fittings, bushings, close nipples and street elbows will not be allowed.
16 Cleaning: clean equipment, materials and piping on inside and outside from loose mill scale, blisters, sand, plaster, paint droppings, dirt, oil, grease, labels and all foreign matter.

17 Cleaning of Drainage System: after completing each section clean pipes, fittings, valves and accessories internally by flushing with clean water.

14.3.10 Pipework Support

1 Support piping independently of equipment.

2 Support piping at intervals to avoid dirt traps.

3 Spans: specified maximum spans are for straight runs of pipe.

4 Locate supports to carry weight of pipe, valves, fittings, insulation, appurtenances and contents without sagging.

5 Locations: in addition to maximum spans specified, location of supports and hangers is to take into account concentrated loads, elimination of overhung sections or bends, load reaction on terminal connections, pipe expansion and contraction, vibrations, hydrostatic testing, water hammer and seismic forces.

6 Locations: reduce spacing of supports to less than three quarters of maximum spans specified where changes in direction or branch connections occur.

7 Locations: locate supports immediately adjacent to changes in direction of piping, branch connections and concentrated loads irrespective of maximum spans specified.

8 Support Risers independently of adjacent horizontal hangers.

9 FIX supports to structure with masonry expansion bolts without causing overstress to structure.

10 Intermediate Steel Elements: provide where required to transfer loads to areas of structure where they can be safely accommodated.

11 Masonry Expansion Bolts: drill in structure and install in accordance with manufacturer's instructions.

12 Spring Cushions: use where horizontal pipe is subject to considerable vertical movement or vibration.

13 Temporary Hangers And Supports will not be allowed. Do not use wire, metal bands, rope, wood, chain, strap or perforated bar. Do not hang pipes from other pipes.

14 Underground Pipe Excavation: trench is not to be open too far in advance of pipe laying and then back-filled as soon as possible.

15 Underground Pipe Bedding: use free draining sand, gravel, loam or soil. Compact fill firmly between side of pipe and trench. Bedding to be thoroughly compacted in layers not exceeding 150 mm to give uniform bed. Lay pipes
directly on bedding. Do not use brick or hard material under pipe. Further bedding material to be placed around pipe and thoroughly compacted in 75 mm layers by careful tamping.

16 Underground Pipe: backfill trench above pipe in layers 300 mm thick each layer well rammed. First layer above pipe must be 150 mm thick.

17 Underground Pipe: comply with manufacturer's recommendations for laying underground pipe.

18 Special Adaptors: use for connecting PVC pipes and fittings to pipes of other materials.

14.3.11 Testing

Apply hydraulic leakage test. Do not apply smoke testing for polypropylene pipe work unless, after obtaining Engineer's approval, be certain that the products of combustion of the smoke generating set will have no detrimental effect on polypropylene.
15. UPVC PIPES AND FITTINGS FOR PRESSURE PIPING

15.1 GENERAL

15.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General Conditions and Conditions of Particular Application apply to this Section.

15.1.2 Description of Work

1 This section specifies unplasticized polyvinyl chloride (UPVC) pipes and fittings for pressurized wastewater system (pressure main) as required by the Contract.

15.1.3 Reference Standards

1 The work of unplasticized polyvinyl chloride (UPVC) pipes and fittings shall conform to the stipulations of the latest edition of the German Standards (DIN), the Qatar Construction specification rules and regulations guide for plumbing and drainage works, the British Standard Specifications (BS) and the specifications of the American Society for Testing and Materials as noted herein below or other equivalent international standards.

<table>
<thead>
<tr>
<th>BS 3505</th>
<th>(UPVC) pressure pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 4346</td>
<td>Joints and fittings for use with UPVC pressure pipes</td>
</tr>
<tr>
<td>BS EN1401-1</td>
<td>Plastics piping systems for non-pressure pipes</td>
</tr>
<tr>
<td>BS EN1401-1</td>
<td>Plastics piping systems for non-pressure underground drainage and sewerage.</td>
</tr>
<tr>
<td>ASTM – D 1785</td>
<td>UPVC Pipes Schedule 80</td>
</tr>
<tr>
<td>ASTM – D 2467</td>
<td>UPVC Pipes Fittings Schedule 80</td>
</tr>
<tr>
<td>ASTM – D 2464</td>
<td>UPVC Fittings Schedule 80</td>
</tr>
<tr>
<td>DIN 8061-8062</td>
<td>UPVC Pipes – Dimensions</td>
</tr>
<tr>
<td>DIN 8063</td>
<td>UPVC Fittings</td>
</tr>
</tbody>
</table>

15.1.4 Submittals

1 Submit the following in accordance with Conditions of the Contract and Division 1 Specification sections:

(a) Materials list and manufacturer’s data
(b) Certificates of compliance
(c) Representative samples of pipes, fittings and accessories to be used in the work
(d) Shop drawings
(e) Installation structure and method of jointing
(f) Post-installation test procedures
(g) Maintenance data

15.1.5 Quality Assurance

1 Inspection and Test by the Manufacturer: Pipe and fittings shall be thoroughly inspected by the manufacturer before delivery. The manufacturer shall make all tests as specified herein and the results of the tests shall be furnished to the contractor upon request in accordance with mutually acceptable arrangement. The manufacturer may use his own or other suitable facilities for the performance of the inspection and test requirements specified herein. Fittings shall be suitably inspected for soundness and fragility.

2 Certification: The Contractor shall submit to the Engineer, prior the delivery of goods, the conformance certification of the manufacturer, test results or copies of test reports which include specific gravity, coefficient of linear expansion, thermal conductivity at 40°C, specific heat, softening water absorption, maximum continuous temperature rating, tensile strength, resistance limit under constant load, modulus of elasticity, flexural strength, compressive strength, elongation at break, flame retardant and other required test reports.

15.1.6 Delivery, Storage and Handling

1 Care shall be exercised in handling, loading, transporting unloading and storing pipes and fittings to avoid distribution, scratches, gouges, dents and particular scuffing of the ends. Pipes shall be transported in a vehicle having a bed long enough to provide support for the full length of the pipe. Pipe or fitting that has been damaged or distorted shall be replaced. Pipes and fittings shall be stored under cover in a flat horizontal position to prevent sagging or bending and protected from direct sunlight and harmful soil elements until ready for installation.

2 Place no pipe or other material inside any other pipe at any time.

15.1.7 Related Works & Sections

1 The following works relate to this section:

2 Earthwork

3 Concrete and Reinforced Concrete

4 Hangers and Supports

5 Plumbing Works

15.2 PRODUCTS

15.2.1 Pipe, Fittings and Accessories

1 General: Pipe, fittings and accessories shall be produced from a material substantially consisting of unplasticized polyvinyl chloride (UPVC). Only those additives that are needed may be used for the manufacture of the polymer and for its conversion into sound, durable extrusions or moldings of good surface finish, mechanical strength and opacity.
2 Pipes and fittings shall be of solvent cemented type joints and flanged with flange adaptors.

3 Cutting to Length and Chamfering: Pipes shall be of such kind that can be cut to length using fine tooth wood saw, a wheel type plastic tubing cutter, or hacksaw and of an end which can be chamfered with one of the special hand tools developed for shaping plastics.

4 Material: unplasticized polyvinyl chloride (UPVC).

5 Dimensions
   (a) Pipes: According to BS 3505 Class E
   (b) Fittings: According to BS 4346

6 Quality
   (a) Pipes and fittings: According to BS Code for pipes & fitting.

7 Operating Pressure: For cold water at 20°C: up to 20 bar. The regulations and guide-lines-dealing with the different fields of application are to be observed.

8 Physical Characteristics
   (a) General Properties and Appearances: Pipes shall be reasonably round, homogenous throughout, free from voids, cracks and other defects that would impair the performance in service; and as uniform as commercially practical in color, density and other physical properties.
   (b) Pipe surface shall be free from nicks, scratches and other blemishes. The joining surfaces of pipe shall be free from gauges and other imperfections that may cause leakage at joints.
   (c) The internal and external surfaces of pipe shall be smooth, clean and reasonably free from grooving and other defects. Pipes shall be reasonably straight.

9 Marking: Pipes shall be indelibly marked. In no case shall mark intervals exceed 3 m. Pipe markings shall continuously include the following:
   (a) Manufacturer’s name
   (b) Nominal size
   (c) Identification code

10 All fittings shall be marked on the body on hub on both sides. The marking shall, at least consist of the manufacturer’s name or trace mark or both.

15.2.2 Jointing

1 Solvent cement jointing as per installation requirements and manufacturer’s recommendations.
15.3 EXECUTION

15.3.1 General

1. Comply to Plumbing Specs, Section 19 part “Plumbing Works” and the manufacturer’s recommendations.

15.3.2 Preparation for Jointing

1. Cut the pipe at right angles to the pipe end, cut off at least 5 cm beyond any visible crack.

2. Take care that the pipe end is free from burrs or cutting chips and remove if necessary.

3. Mark the welding depth at the end of the pipe

4. Mark the desired position of the fitting on the pipe and/or fitting.

15.3.3 Jointing

1. The pipe cut with a wheel-type plastic tubing cutter, a hack saw or other fine toothed hand or power saws. Use of ratchet cutters is permitted. Ensure that the cut is square when using a saw.

2. Cutting tubing as squarely as possible provides optimal bonding area within the joint. If any indication of damage or cracking is evident at the tubing end, cut off at least 5 cm beyond any visible crack.

3. Burrs and filings can prevent proper contact between tube and fitting during assembly, and should be removed from the outside and inside of the tubing.

4. Use pocketknife or file are suitable for chamfering.

5. A slight bevel on the end of the tubing will ease entry of the tubing into the fitting socket and minimize the chances of pushing solvent cement to the bottom of the joint.

6. Wipe any dirt or moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket, tubing should not bottom out in the socket.

7. Primer or cleaner prepares the bonding area for the addition of solvent cement and subsequent assembly. A dauber or natural bristle paint brush approximately 1/2 the size of the tubing diameter is appropriate. Apply primer to both the outside of the tubing end and in the fitting socket.

8. Do not allow primer to puddle in the fitting.

9. Use only uPVC solvent cement when the primed pipe and fitting surfaces are dry, apply a heavy, even coat of cement on the tubing end. Apply a thin coat inside the fitting socket.

10. Immediately, insert the tubing into the fitting socket, rotating the tubing ¼ to ½
turn while inserting. This motion ensures an even distribution of cement with the joint. Properly align the fitting. Hold the assembly for approximately 10 seconds. Allowing the joint to set-up. An even bead of cement should be evident around the joint. If this bead is not continuous around the socket edge, it may indicate that insufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and fittings surfaces for an attractive, professional appearance.

15.3.4 Pipe Movements

1. Provide expansion joint to prevent pipe movements due to thermal expansion or to relevant movements at building expansion joints. When underground pipe extended outside the building structure, provide pipes in shell for inside and outside the building structures.

2. Indicate clearly on shop drawings the locations and details of expansion joints.

3. Apply as a guide the following installation procedure:

   (a) The maximum distance between entry and the nearest fixed point must be 500 mm.

   (b) Where pipe work penetrates a fire barrier, the pipe must be fire stopped. If this prevents thermal movement expansion joints must be provided.

   (c) Use suitable pipe clamp taking into consideration the pipe route has to be planned and installed in a way that the pipe is free-moving within the determined expansion as recommended by Manufacturer.

   (d) Maximum vertical support intervals must not exceed 1800 mm for all sizes.

15.3.5 Maximum Support Distances

1. Support independently every length of pipe. Intermediate supports should be provided for long lengths of pipe where necessary in accordance with Table 1.

2. Hangers and straps shall not compress, distort, cut or abrade the piping. Maintain vertical piping in straight alignment.

<table>
<thead>
<tr>
<th>Nominal Size mm</th>
<th>Maximum Support Distances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal (m)</td>
</tr>
<tr>
<td>100 and smaller</td>
<td>0.9</td>
</tr>
<tr>
<td>150</td>
<td>1.2</td>
</tr>
</tbody>
</table>

3. Ensure that the supporting system shall accommodate expansion and contraction. Use only supports that fit accurately to the pipes and fittings.

15.3.6 Testing

1. Apply hydraulic leakage test. Do not apply smoke testing for UPVC pipe work unless, after obtaining Engineer’s approval, be certain that the products of
Combustion of the smoke generating set will have no detrimental effect on UPVC.
16. MECHANICAL IDENTIFICATION

16.1 GENERAL

16.1.1 Reference

1 Conform to General Requirements for Mechanical Services of mechanical specs (Plumbing – Fire).

2 Reference Standards:
   - BS 381C Specification for colours for identification, coding and special purposes.
   - BS 729 Specification for Hot dip galvanized coatings on iron and steel articles.
   - BS 1710:1980 Identification of pipelines and services.
   - BS 4652 Specification for metallic zinc-rich priming paint.
   - BS 4800 Paint colours for building purposes.
   - BS 5378 Part 1, Safety Signs and Colours - Specification for Colour and Design

16.1.2 SUBMITTALS

1 All materials submittals shall include a detailed, clause-wise, compliance statement.

2 All materials submittals shall include detailed catalogues, product literature and descriptions of all equipment and fittings with selection charts, capacities etc.

3 All material submittals shall include copies of relevant standards.

4 Contractor shall submit samples of each type of identification for company approval.

16.2 PRODUCTS

16.2.1 Pipework Identification

1 Standards - Colour code and label to BS 1710.

2 Primary Identification: Apply colour bands, 300mm wide, in accordance with BS 1710: 1980, to each pipe at least once in every room or enclosed area; at intervals not exceeding fifteen metres; at every junction; at every valve; and at every inspection and access position into service shafts, false ceilings, bulkheads etc.

3 Colour bands shall not be provided on pipes which are to be painted to match internal decorations.

4 Where two or more pipes run in parallel, then the colour banding for each pipe shall be at the same locations.
5 At intervals as for colour banding, coloured arrows and wording shall be stenciled to the insulation or pipework to indicate direction of flow, and to indicate the circuit or system.

6 Secondary Identification: Apply colour bands, 50mm wide, in accordance with BS 1710: 1980, and superimpose a legend identifying circuit, direction of fluid or gas flow, nominal pipe bore and, where appropriate, fluid or gas pressure.

7 Colour bands shall not be provided on pipes which are to be painted to match internal decorations.

16.2.2 Pipework Markings

1 In addition to the identification band coding all services shall be legibly and neatly marked with black letters where a light background is used and white letters where a dark background is used and appropriately coloured triangles to indicate the direction of flow as follows:

- (a) Cold Water Service CW
- (b) Hot Water Services HW
- (c) Hot water return HWR
- (d) Fire Water Services FW
- (e) Irrigation Water Services IRR
- (f) Gray Water Service GW
- (g) Treated Water Service TW
- (h) REF Piping – Suction
- (i) REF Piping – Liquid

16.2.3 Plant and Equipment Identification General

1 Each of the MEP plant units and equipment shall be factory painted in accordance with the manufacturer’s recommendations to a colour designated and approved by the Design Consultant. Any damage to finishes which may have occurred during transit, storage, installation or otherwise shall be made good in the manner recommended by the manufacturer and to the satisfaction of the Client/Engineer.

2 Specification Plates: Each unit shall have a specification metal plate (the manufacturer’s name plate) which shall show full details as manufacturer’s name, unit and unit motors serial numbers, model numbers, date of manufacture and BS or other number for the internationally approvable standard to which the item of plant conforms:

3 Pumps: Pump size, rpm, amperes, impeller diameter, lubricants, pump characteristics, flows for the duty specified, the K factor of the orifice plate if applicable, and any other pertinent information as may be required by the Client/Engineer. This plate shall also be securely fixed to the pump.

4 Identification plates: In addition to the specification plates, each unit shall be provided with an identification plate showing the code number for each unit as
indicated on the system schematics. This plate shall be securely fixed to the unit in a prominent position.

16.2.4 Plant and Equipment Identification, Engraved Plates

1 Standards: Identify each item of equipment by name and, where appropriate, by agreed reference characters. Provide colour identification as called for in work sections and, in all cases, colour fire fighting equipment red.

2 Identification Colours: Use primary and secondary identification colours of associated system.

3 Plates: Use rectangular metal plates securely fixed to each item of equipment. Size shall be as per Client/Engineer approval.

4 Lettering: Engraved plates filled with paint.

5 Legends: Engrave plates with an approved text. Incorporate operating duty of equipment where this is not incorporated in other labeling.

16.2.5 Valve and Cock Identification

1 Standards: Identify each valve, cock, stop valve, air vent, drain cock etc. with disk engraved with numerical reference. Except where exposed in occupied areas.

2 Identification Colours: Use primary and secondary identification colours of associated system for painted or self colour discs.

3 Discs and Labels: Securely attach metal discs, minimum diameter 35mm, to each item. The labels for valves as alternatives shall be brass 80 mm by 40 mm with a hole 10 mm from one end. A short length of brass chain with a ring at each end shall be used to permanently attach the labels to each valve.

4 Legends: Engrave discs with permanent characters, minimum height 10mm. Each label shall indicate the type of service and the valve reference number which shall agree with a schedule of valves which shall be prepared for each service. The schedule shall comprise the valve reference number, the function of the valve and its location.

5 Incorporate in operating instructions relating to regulating valves and flow measuring equipment, details of flow rate, pressure differential and setting, as appropriate.

16.2.6 Instrument Identification

1 Standards: Identify each instrument by name and, where appropriate, by agreed reference characters.

2 Plates: Use rectangular metal securely fixed to each instrument.

3 Legends: Engrave plates with an approved text.
16.2.7 Danger and Warning Notices

1 Hazardous Systems: Colour code and label hazardous systems and equipment to requirements of Health and Safety Executive Guidance Notes.

2 The warning flash as specified in BS 5378 Part 1, "Safety Signs and Colours - Specification for Colour and Design" shall be attached to all internal and external removable covers of electrical equipment and panels, which provide shielding from live conductors.

3 Labels to be in both Arabic and English.

16.2.8 System Identification Installation Charts, Perspex Glazed Frame

1 System Schematics: Supply and fix a referenced plastic laminated schematic diagram (or diagrams) of all systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram.

2 Identify all items by appropriate reference characters.

3 Control Schematics: Supply and fix plastic laminated referenced schematic diagram (or diagrams) of all control systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram.

4 Identify all items by appropriate reference characters.

5 Valve Charts: Supply and fix complete valve charts for water, hot water and fire water services separately, showing valve No. and location.

6 Location: Fix in each plant room or equipment room.

7 Finish: Perspex sheet glazing with surrounding hand plastic frame and mounting attachments.

8 Identify all items by appropriate reference characters.

9 Equipment Schedule: Supply and fix all equipment schedule for plumbing and fire protection systems separately.

16.3 EXECUTION

16.3.1 Miscellaneous

1 Colour not covered by this Specification must be agreed with the Client/Engineer before work commences on site.

2 Labels shall be permanently fixed using rivets or self tapping screws, sharp edges or tips of the screws, shall be removed.

3 Control devices, shall be labeled by reference and function in accordance with circuit and layout diagrams.

4 Similar labels shall be affixed below each instrument on the instrument panel and shall indicate the purpose of the instrument and the respective boiler, tank or
other appliance to which its recordings are applicable, and all relevant performance data as appropriate to the item of plant to enable easy identification at a later date.

5 Cables shall be permanently designated using sleeves or ferrules at every termination in accordance with schematic wiring diagrams.

6 All terminals shall be designated in accordance with circuit and layout diagrams. The designation of terminals may be achieved by the use of proprietary labels supplied as part of the product supplied by the terminal manufacturer.

7 All valves controlling mains and sub-circuits for all services shall be labelled before the works are commissioned in accordance with a schedule of valves, which shall correspond with valves indicated upon the final as-installed drawings and any circuit control diagrams considered necessary.

8 The Contractor shall supply details of the tagging system he intends to use together with a schedule of all valves and equipment with a dedicated tag number related to location to the Client/Engineer before installation of these items will be allowed to commence.

The schedules and schematic diagrams shall be framed and glazed and hung in the relevant plant rooms; an alternative method may be submitted to the Client/Engineer for approval. Duplicate copies of the schedules and schematic diagrams shall be submitted to the Client/Engineer for approval.
17. VALVES FOR PLUMBING WORKS

17.1 GENERAL

17.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General Conditions, Conditions of Particular Application apply to work of this section.

17.1.2 Description of Work

1 This section includes the following general duty valves as required by the Contract:

(a) Gate Valves
(b) Globe Valves
(c) Check Valves
(d) Butterfly Valves
(e) Stop Valves
(f) Drain Cocks
(g) Ball Valves

2 Special purpose valves are specified in individual piping systems specifications. Extent of each type of valves and nominal diameters shall be as shown on Drawings.

17.1.3 Submittals

1 Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections:

2 Product data: including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances and installation instructions.

17.1.4 Quality Assurance

1 Provide valves, where possible, from a single approved source.

17.1.5 Reference Standards

1 Unless otherwise directed, the work of valves shall be performed in accordance with the Qatar Construction specification rules and regulations guide for plumbing and drainage works, and the stipulations of the specifications indicated herein below:

(a) British Standard BS
(b) International Organization for Standardization
(c) ISO No.
17.1.6 Delivery, Storage and Handling

1 Preparation for Transport: Prepare valves for transportation as follows:

2 Ensure Valves: are dry and internally protected against rust and corrosion.

3 Protect Valve Ends: against damage to threads, flange faces, and weld-end preps.

4 Set Valves in Best Position for Handling: Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.

5 Storage: Use the following precautions during storage:

6 Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.

7 Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.

8 Handling: Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use hand wheels and stems as lifting or rigging points.

17.2 PRODUCTS

17.2.1 Manufacturers

1 Subject to compliance with requirements of this section, provide products by one of the attached list of manufacturers or approved equal as shown in Section 01270.

17.2.2 Valve Features, General

1 Valve Design: Rising stem or rising outside screw and yoke stems.

2 Non-rising Stem Valves: may be used where headroom prevents full extension of rising stems.

3 Pressure and Temperature Ratings: As required to suit system pressures and temperatures.

4 Sizes: Same size as upstream pipe, unless otherwise indicated.
5 Operators: Provide the following special operator features:

(a) Hand wheels, fastened to valve stem, for valves other than quarter turn.
(b) Lever handles on quarter-turn valves 150 mm and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10-plug valves.
(c) Chain-wheel operators for valves 65 mm and larger, installed 1800 mm or higher above finished floor elevation. Extend chains to an elevation of 1500 mm above finished floor elevation.

17.2.3 Material and Marking

1 Bronze valves used with the domestic cold and hot water system shall be resistant to dezincification. Under no circumstances shall "Duplex" brass fittings be used. Cast iron valves used with domestic cold and hot water system shall be lined. Each valve shall be marked with cast-on lettering giving the following information:

(a) Manufacturer's Name or Trade Mark
(b) Size of Valve
(c) Guaranteed Working Pressure
(d) International Standard Reference

17.2.4 Gate Valves

1 Gate Valves 50 mm and Smaller: Class 125, conforming to BS 3952 &

2 BS 5154 cast bronze; with threaded ends, solid disc, copper-silicon alloy stem, bronze packing gland, "Teflon" impregnated packing and malleable iron hand wheel.

3 Gate Valves, 65 mm and Larger: Class 125, cast iron body, bronze mounted, with body and bonnet conforming to BS 3952 & BS 5155; with flanged ends, "Teflon" impregnated packing and two-piece packing gland assembly, solid wedge type gate-high tensile forged bronze spindle engaging a gunmetal nut at the top of the gate, cast iron spindle caps and hand wheels..

17.2.5 Check Valves

1 Swing Check Valves 50 mm and Smaller: Class 125, cast-bronze body and cap conforming to BS5154; with horizontal swing, Y-pattern and bronze disc and having threaded ends. Provide valves capable of being reground while the valve remains in the line.

2 Wafer Check Valves 65 mm and Larger: Class 125; cast iron body, conforming to BS5154, flanged ends with replaceable bronze seat and non-slam design lapped and balanced with bronze flabbers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately 3-kPa pressures. Provide valves capable of being refitted while the valve remains in the line.
17.2.6 Butterfly Valves

1 Butterfly Valves 65 mm and Larger: Rated for 850 kPa, cast-iron body conforming to BS 5155. Provide valves with field replaceable EPDM sleeve, nickel-plated ductile iron disc, stainless steel stem, EPDM O-ring stem seals and lever operators with locks. Provide lug or wafer type as indicated.

2 Drill and tap valves on dead-end service or requiring additional body strength. Provide, for insulated valves, a long neck feature.

17.2.7 Ball Valves

1 Ball Valves 25 mm and Smaller: Valves shall be standard port, 2-piece construction with screwed ends. Valves shall be designed for minimum PN23.

2 Valves shall have bronze or brass body, chromium plated or stainless steel ball, steel handle with vinyl grip, and replaceable teflon seats.

3 Size 65 mm and Larger: Valves shall be standard port, BS 5159 with flanged ends. Valves shall be designed for minimum PN1 6 working pressure.

4 Valves shall have steel body, chrome or nickel plated steel or stainless steel ball, replaceable teflon seats, and steel stem and handle.

5 Where required for installation in the fire protection system, the ball valves shall be FM approved.

17.2.8 Stop Valves

1 Stop valves shall be screw down pattern, with chrome plated gunmetal bodies and screwed connections.

17.2.9 Drain Cocks

1 Drain cocks shall be plug type with hose union connector, loose key and gunmetal body.

17.2.10 Identification Labels

1 All stop valves shall be provided with white plastic identification labels indicating in black lettering the number and duty of the valve.

17.2.11 Float Valves

1 Float valves shall be installed as indicated in the drawings to provide consistent level control in reserve supply water storage tanks. The valve shall meet the requirements of the Water Byelaws for air gaps and shall be constructed throughout in approved materials and shall prevent back siphoning. Inlet flow shall be co-axial with the piston movement, to ensure high discharge capacity and smooth, quiet operation. The valve shall have '0' ring piston seals, resilient seated disk, Dezincification resistant bronze fabricated approved solder and shall be hydraulically tested to ensure buoyancy and constructed in accordance with BS1968.
2 Bronze equilibrium float valves 80 and above shall be flanged end, flat faced and drilled to suit BS4504 PN1 6.

3 Bronze equilibrium float valves up to 50 shall be screwed end BS2779 parallel and shall be provided complete with back nut.

4 Floats for valve sizes 80mm and above shall be of copper.

17.2.12 Stainless steel tank:

1 To be welded all stainless steel shell. The tank shall be constructed in #316 stainless steel, with a minimum storage of 265 gallons (1000 liters), tested at 250 psi for 125 psi working pressure for connection to city water. Storage tank shall be equipped with drain connection and insulated with closed cell thermo-elastomer, with R factor of 3.7 and housed in rust proof steel cabinet.

2 Tank dimensions shall be as indicated on the drawings. Tank shall include air vent with adquate size. The Tank shall be supported on adquate skid and all required strengthening that suit tank dimensions.

3 After installation, tanks shall be filled with water for testing for 24 hours. No leakage shall be observed. On completion of leak tests, the tank shall be flushed out twice using maximum water pressure available and all extraneous matter removed including the water used during the operation. The whole of the installation shall be guaranteed for a period of 10 years. Any defect/damage or leakage occurred during the guarantee period shall be made good by the Contractor at no cost to the Client.

17.3 EXECUTION

17.3.1 Examination

1 Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.

2 Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the shipping position.

3 Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.

4 Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length and material. Check gasket material for proper size, material composition suitable for service and freedom from defects and damage.

5 Prior to valve installation examine the piping for cleanliness, freedom from foreign materials and proper alignment.
6 Replace defective valves with new valves.

17.3.2 Valve Ends Selection

1 Select valves with the following ends or types of pipe/tube connections:

2 Pipe Sizes 50 mm and Smaller: threaded.

3 Pipe Sizes 65 mm and Larger: flanged for plumbing works sockets for infrastructure works.

17.3.3 Valve Installations

1 General Application: Use gate, ball and butterfly valves for shut-off duty, globe and butterfly for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.

2 Locate valves for easy access and provide separate support where necessary.

3 Provide dielectric insulation for connecting bronze valves with steel piping.

4 Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

5 Install three-valve bypass around each pressure-reducing valve using throttling-type valves.

6 Install valves in horizontal piping with stem at or above the center of the pipe.

7 Install valves in a position to allow full stem movement.

8 Install swing check valves for proper direction of flow, i.e., horizontal position with hinge pin level.

9 Provide surface box assemblies for operating buried valves with T-handled key.

10 Threaded Connections: Note the internal length of threads in valve ends and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.

11 Align threads at point of assembly.

12 Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

13 Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

14 Flanged Connections: Align flange surfaces parallel.

15 Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using a torque wrench.
16 For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

17.3.4 Field Quality Control

1 Testing: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.

17.3.5 Adjusting and Cleaning

Cleaning: Clean mill scale, grease and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
18. HANGERS AND SUPPORTS

18.1 GENERAL

18.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General Conditions, Conditions of Particular Application apply to work of this section.

18.1.2 Description of Work

1 This section specifies pipe hangers and supports and includes the following:

(a) Horizontal-piping hangers and supports
(b) Vertical-piping clamps
(c) Hanger-rod attachments
(d) Building attachments
(e) Protection shields
(f) Mechanical-Anchor fasteners
(g) Miscellaneous materials
(h) Equipment supports

18.1.3 Reference Standards

1 The work of hangers and supports shall be performed in strict accordance with the stipulations of the latest edition of the Qatar Construction specification rules and regulations guide for plumbing and drainage works, and the following codes and standards:

2 American Society for Testing and Materials

3 ASTM No.

   (a) A 36 Specifications for Structural Steel
   (b) A 780 Practice for Repair of Damaged Hot-dipped Galvanized Coatings
   (c) American Society of Mechanical Engineers

4 ASME No.

   (a) B 31.9 Building Services Piping

5 British Standard

   (a) BS 5572: 1978.

6 National Fire Protection Association (NFPA).

7 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
8 MSS SP No.

(a) 58 Pipe Hangers and Supports - Materials, Design and Manufacture.
(b) 69 Pipe Hangers and Supports - Selection and Application
(c) 89 Pipe Hangers and Supports - Fabrication and Installation Practices.
(d) 90(R 91) Guidelines on Terminology for Pipe Hangers and Supports

18.1.4 Performance Requirements

1 Obtain Engineer's approval for arrangements of seismic resistance hangers and supports for piping and equipment.

18.1.5 Submittals

1 Submit the following in accordance with Conditions of the Contract and all Specification Sections:

(a) Product data including installation instructions for each type of hanger and support. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location and features for each required pipe hanger and support.

(b) Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

(c) Welder certificates signed by the Contractor certifying that welders comply with requirements specified under Clause 1.6, "Quality Assurance".

(d) Assembly-type shop drawings for each type of hanger and support indicating dimensions, weights, required clearances, and methods of assembly of components.

(e) Maintenance data for hangers and supports for inclusion in Operating and Maintenance Manual

18.1.6 Quality Assurance

1 Welders Qualifications: Qualify welding processes and welding operators in accordance with British Standard Specifications.

2 Certify that each welder has satisfactorily passed ES No. 917 qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

3 Qualify welding processes in accordance with requirements of ES No. 243, 257 and 435, 921 and 1169.

4 Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of hangers and supports.

5 NFPA Compliance: Hangers and supports shall comply with NFPA standard No. 13 when used as a component of a fire protection system and as a guide for the installation of other piping system.
18.1.7 Related Works & Sections

1 The following works & sections relate to this section:

2 Metal Fabrications works for materials for anchoring piping systems to building structure.

3 Painting works for field-applied painting requirements.

4 Plumbing sections "Pipe Expansion Joints" for expansion joints and expansion loops.

5 Section "Mechanical Insulation" for pipe insulation.

18.2 PRODUCTS

18.2.1 Manufactured Units

1 Hangers, supports and components factory-fabricated according to MSS SP-58 (Manufacturers Standardization Society Standard Practice – 58)

2 Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.

3 Select pipe hangers to support water test as well as the piping loads and to control movements from thermal expansion as listed below and as recommended by MSS SP. 69 (Manufacturers Standardization Society Standard Practice – 59).

4 Provide hangers and supports in accordance with the following listing:

5 Horizontal-Piping Hangers and Supports:

6 Overhead Pipe: MSS type 1, adjustable steel clevis hanger for suspension of non-insulated or insulated stationary pipes.

7 MSS Type 43, adjustable roller hanger with swivel for suspension of pipes where horizontal movement may occur because of expansion and contraction.

8 Holder bats for piping fixed adjacent to walls and ceilings.

9 Provide hangers and supports – located inside the agents’ areas with rubber gaskets.

10 Floor Mounted Pipes: MSS Type 38, adjustable pipe saddle support with welded joint steel pipe base support, cast-iron floor flange and U-bolt.

11 Vertical Piping Clamp: MSS Type 8, Riser clamp to support and steady pipe riser.

12 Hanger-Rod Attachments

13 MSS Type 13, steel turnbuckles.

14 MSS Type 16, malleable iron rod sockets to attach hanger rods to various types
of building attachment.

15 **Hanger Rod:** Hot-rolled, threaded galvanized steel. Rod size shall be as indicated below.

<table>
<thead>
<tr>
<th>Pipe Size mm and smaller</th>
<th>Rod Size mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm and smaller</td>
<td>10</td>
</tr>
<tr>
<td>65-80 mm</td>
<td>12</td>
</tr>
<tr>
<td>100-125 mm</td>
<td>16</td>
</tr>
<tr>
<td>150 mm</td>
<td>19</td>
</tr>
<tr>
<td>200-300 mm</td>
<td>22</td>
</tr>
<tr>
<td>350-400 mm</td>
<td>25</td>
</tr>
</tbody>
</table>

16 **Building Attachments:** MSS Type 18, steel concrete inserts for upper attachment to suspend pipe hangers from a concrete slab.

17 MSS Type 31, 32, welded steel brackets to support pipe from below for suspending from above by using clip and rod for pipes run near wall.

18 **Protection Shields:** MSS Type 40, of sufficient length to prevent insulation crushing.

19 **Mechanical-Anchor Fasteners:** For concrete slabs greater than 100 mm thick, insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

**18.2.2 Miscellaneous Materials**

1 **Structural Steel:** ASTM A 36 M, steel plates, shapes and bars, black and galvanized.

2 **Bolts and Nuts:** ASME B 18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.

3 **Washers:** ASTM F 844, steel, plain, flat washers.

4 **Field-Fabricated, Heavy-Duty Steel Trapezes:** Fabricate from steel shapes selected for loads required; weld steel.

5 **Cement Grout:** clean uniformly graded, natural sand grading requirement as per Table 1. Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
Table 1

Grading requirements for fine aggregates

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Amounts Finer than each Laboratory Sieve (Square Openings), Weight Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2-in (12.5 mm)</td>
<td>-</td>
</tr>
<tr>
<td>1/4-in (9.5 mm)</td>
<td>-</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 8 (2.36-mm)</td>
<td>95 to 100</td>
</tr>
<tr>
<td>No. 16 (1.18-mm)</td>
<td>70 to 100</td>
</tr>
<tr>
<td>No. 30 (600-mm)</td>
<td>40 to 75</td>
</tr>
<tr>
<td>No. 50 (300-mm)</td>
<td>10 to 35</td>
</tr>
<tr>
<td>No. 100 (150-mm)</td>
<td>2 to 15</td>
</tr>
<tr>
<td>No. 200 (75-mm)</td>
<td>-</td>
</tr>
</tbody>
</table>

6 Maximum Pipe Support Spacing: Hangers and support spacing applied for straight pipes shall be as follow:

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Pipe Size (mm)</th>
<th>Maximum Spacing (m)</th>
<th>Vertical</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>200 mm and 150 m</td>
<td>4.60</td>
<td>3.70</td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>100 and smaller</td>
<td>3.70</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>25 mm and smaller</td>
<td>2.4</td>
<td>1.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35 – 40 mm</td>
<td>3.0</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 mm</td>
<td>3.0</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65 – 100 mm</td>
<td>3.7</td>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

7 Additional hangers and supports shall be provided where concentrated weights such as valves or heavy fittings, or where change of direction of the piping system, occur between hangers.

8 The direct attachment of steel or iron hangers and supports and copper shall not be allowed.

18.3 EXECUTION

18.3.1 Examination

1 Examine substrates and conditions under which supports and anchors shall be installed. Do not proceed with installing until unsatisfactory conditions have been corrected.

18.3.2 Installation of Hangers and Supports

1 General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacing complying with MSS SP-69 and Part 2 Item No. 2.2.6. Where
piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

2 Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads including valves, flanges, guides, strainers, expansion joints and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength equals 180 kg/cm² is indicated, install reinforcing bars through openings at top of inserts.

3 Support piping for fire protection systems independently from other piping systems.

4 Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

5 Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement shall not be transmitted to connected equipment.

6 Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

7 Pipe Slopes: Install hangers and supports to provide required pipe slopes and so that maximum pipe deflections allowed by ASME B 31.9 is not exceeded.

8 Insulated Piping: Comply with the following installation requirements.

9 Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B 31.9.

10 Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

11 Shields: Install protective shields MSS Type 40 on piping that has vapor barrier. Shields shall span an arc of 180 and shall have dimensions in mm not less than the following:

<table>
<thead>
<tr>
<th>Pipe Size (mm)</th>
<th>Length (mm)</th>
<th>Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 THROUGH 80</td>
<td>300</td>
<td>1.22</td>
</tr>
<tr>
<td>100</td>
<td>300</td>
<td>1.52</td>
</tr>
<tr>
<td>125 &amp; 150</td>
<td>450</td>
<td>1.52</td>
</tr>
<tr>
<td>200 THROUGH 350</td>
<td>600</td>
<td>1.91</td>
</tr>
<tr>
<td>400 THROUGH 600</td>
<td>600</td>
<td>2.67</td>
</tr>
</tbody>
</table>

12 Pipes 200 mm and larger shall have wood inserts.

13 Insert material shall be at least as long as the protective shield.
18.3.3 Installation of Anchors

1. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

2. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B 31.9 and with AWS standards D1.1.

3. Where expansion compensators are required, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

4. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

18.3.4 Installation of Pipe Alignment Guides

1. Install pipe alignment guides on piping that adjoins expansion joints and elsewhere as indicated. Anchor to building substrate.

18.3.5 Equipment Supports

1. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor. Use concrete bases for floor-mounted equipment.

2. Grouting: Place grout under supports for piping and equipment.

18.3.6 Seismic Protection

1. Fixed Floor Mounted Equipment: Anchor equipment base to concrete by means of bolts or inserts.

2. Provide, for equipment with high center of gravity, braces at the top either diagonally down to the floor, to structure above or to the adjacent wall to resist overturning.

3. Provide also strong back steel beams to the tall equipment, on either side and span from floor to floor with vertical slip joint connection to avoid unexpected interaction between floor structures.

4. Do not use cast iron legs or threaded pipes for supporting equipment.

5. Provide diagonal braces between legs of equipment steel frame and provide braces through the support structure and out of the base.

6. Fixed Suspended Equipment: Install equipment, where possible, tightly against the structure members above to eliminate the need for bracing and to prevent slipping.

7. Provide cross braces to ensure lateral stability where the equipment shall be suspended below the supporting member.
8 Use struts to the structural walls, where the equipment are suspended nearby instead of the diagonal bracing.

9 Vibration Isolated Floor Mounted Equipment: Supplement conventional isolators with separate snubbers. Install isolators with built-in restraints and overturning resistance.

10 Vibration Isolated Suspended Equipment: Provide independent laterally stable frame, where space allows, around the equipment with proper operating gaps padded with resilient material.

11 Install equipment as close as possible to the supporting structure. Provide diagonal braces for hanger rods utilized to lower the equipment.

12 Piping System: Apply the same protection measures as that applicable for hanged equipment.

13 Fix piping directly to structural slabs, beams, columns or walls. Pipe hangers suspended less than 300 mm do not require additional protection.

14 Provide for hanger greater than 300 mm, diagonal braces to the structural above or horizontal strut to adjacent structure.

15 Avoid wherever possible pipe crossing the building expansion joints. If unavoidable keep crossing at lowest floor or provide flexible joints.

### 18.3.7 Metal Fabrication

1 Cut, drill and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in proper locations.

2 Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

3 Field Welding: procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work are as the following:-

   (a) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

   (b) Obtain fusion without undercut or overlap.

   (c) Remove welding flux immediately.

   (d) Finish welds at exposed connections so that no roughness shows after finishing and contours welded surfaces match with adjacent contours.

### 18.3.8 Adjusting

1 Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve required slope of pipe.

2 Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same
material as used for shop painting to comply with requirements specified in "Painting works" for touch-up of field-painted surfaces.

3 Apply by brush or spray to provide a minimum dry film thickness of 50 microns.

For galvanized surfaces clean welds bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTMA 780.
19. MECHANICAL INSULATION

19.1 GENERAL

19.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General Conditions apply to work of this Section.

19.1.2 Description of Work

1 This Section includes pipe and equipment insulation.

2 Related Sections: The following sections contain requirements that relate to this section:

   (a) Section "Hangers and Supports" for pipe insulation, shields and protection saddles.

3 Definitions

   (a) Hot Surfaces: Normal operating temperatures of 38°C or higher.

   (b) Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

   (c) Cold Surfaces: Normal operating temperatures less than 23°C.

   (d) Thermal Resistivity: r-values represent the reciprocal of thermal conductivity (k value). Thermal conductivity is the rate of heat flow through homogenous material exactly 1 meter thick. Thermal resistivity is expressed by the temperature difference in degrees °k between two exposed faces required to cause one watt to flow through one square meter of material at a given mean temperature (mk/w).

   (e) Density: Is expressed in kg/m3

19.1.3 Submittals

1 Submit the following in accordance with Conditions of the Contract and Division-1 Specification Sections:

   (a) Product Data: For each type of mechanical insulation identifying k-value, thickness and jackets.

   (b) Shop Drawings: Show fabrication and installation details for the following:

      (i) Application of protective shields, saddles and inserts at pipe hangers for each type of hanger.

      (ii) Insulation application at pipe expansion joints, elbows, fittings, flanges, valves and specialties.

      (iii) Removable insulation at piping specialties and connections.

2 Samples: Of each type of insulation and jacket. Identify each sample describing product and intended use. Submit the following sizes of sample materials:
(a) Board and Block Insulation: 800 mm square section.
(b) Pre-Formed Pipe Insulation: 300 mm long, 50 mm NPS.
(c) Material Certificates: Signed by the manufacturer, certifying that materials comply with specified requirements.

3 Quality Assurance

4 Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements and adhesives when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the Engineer.

5 Label insulation with appropriate markings of testing laboratory.

6 Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

7 Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

8 Field-Constructed Mockup: Before installation, erect mock-up of size and at locations indicated to demonstrate workmanship quality. Include method of attachment and finishing for each piping system.

9 Retain and protect mock-ups during construction as a standard for judging completed unit of Work. Remove mock-ups from Site when directed.

10 Sequencing and Scheduling: Schedule insulation application after testing of piping and duct systems.

19.2 PRODUCTS

19.2.1 Manufacturers

1 Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal as shown in Section 01295.

19.2.2 Glass Fiber

1 Material: Inorganic glass fibers, bonded with a thermosetting resin.

2 Jacket: All-purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.

3 Board: ASTM C 612, Class 2, semi-rigid jacketed board.

4 Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets.

5 Preformed Pipe Insulation: ASTM C 547, Type I jacketed with 0.03 W/m.°K (at 10°C) minimum thermal conductivity and 80 kg/m³ average density.

6 Adhesive: Produced under the UL Classification and Follow-up service, non-
flammable, solvent-based type with service temperature range from -6°C to +83°C.

7 Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

19.2.3 Jackets

1 General: ASTM C 921, Type 1, except as otherwise indicated.

2 Foil and Paper Jacket: Laminated glass fiber-reinforced, flame retardant kraft paper and aluminum foil, 0.02 liter per m2 maximum water vapor permeance, when tested according to ASTM E 96, 50 beach units minimum puncture resistance when tested according to ASTM D 781

3 Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, smooth finish, 0.25 mm thick.

19.2.4 Accessories and Attachments

1 Glass Cloth and Tape: 100 mm wide tape woven glass fiber fabrics, plain weave, presized to a minimum of 0.34 grams/mm2.

   (a) Cloth Standard: MIL-C-20079H, Type I.
   (b) Tape Standard: MIL-C-20079H, Type II.

2 Bands: 20 mm wide, 0.15 mm thick galvanized steel.

3 Wire: 16-gage, soft-annealed galvanized steel.

4 Corner Angles: 28-gage, 25 x 25 mm aluminum, adhered to 50 x 50 mm kraft paper.

5 Anchor Pins: Capable of supporting 9 kg each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

19.2.5 Sealing Compounds

1 Vapor Barrier Compound: Water-based, fire-resistive composition with water vapor permeance of 0.08 perm maximum, at temperature range from minus 6 to +83°C.

2 Weatherproof Sealant: Flexible elastomer-based, vapor-barrier sealant designed to seal metal joints with water vapor permeance of 0.02 perm maximum, temperature range from minus 10 to +122 °C, aluminum color.

19.3 EXECUTION

19.3.1 Preparation

1 Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.
19.3.2 Installation, General

1 Refer to schedules at the end of this Section for materials, forms, jackets, and thickness required for each mechanical system. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state. Apply insulation material, accessories, and finishes according to the manufacturer’s printed instructions. Install insulation with smooth, straight and even surfaces. Seal joints and seams to maintain vapour barrier on insulation requiring a vapour barrier.

2 Seal penetrations for hangers, supports, anchors and other projections in insulation requiring a vapour barrier.

3 Taper ends at 45ºC degree angle and seal ends with lagging adhesive. Apply adhesives and coatings at manufacturer’s recommended coverage-per-liter rate. Keep insulation materials dry during application and finishing.

4 Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:
   (a) Testing laboratory labels and stamps.
   (b) Nameplates and data plates.
   (c) Fire protection piping systems.
   (d) Drainage piping located in crawl spaces, unless indicated otherwise.
   (e) Chrome-plated pipes and fittings.
   (f) Piping specialties including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

19.3.3 Pipe Insulation Installation

1 General: Tightly butt longitudinal seams and end joints. Bond with adhesive. Stagger joints on double layers of insulation.

2 Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated. Apply insulation with a minimum number of joints. Apply insulation with integral jackets as follows:
   (a) Pull jacket tight and smooth.
   (b) Cover circumferential joints with butt strips, at least 38 mm wide, and of same material as insulation jacket. Secure with adhesive and outward clinching staples along both edges of butt strip and space 100 mm on center.
   (c) Overlap longitudinal seams at least 38 mm. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive seal-sealing lap. Staple laps with outward clinching staples along edge at 100 mm on center.
   (d) Exception: Do not staple longitudinal laps on insulation applied to piping systems with surface temperatures at or below 1.5ºC.
(e) Apply vapor barrier coatings where vapor barriers are indicated, on seams and joints, over staples, and at ends butt to flanges, unions, valves, and fittings. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor barrier coating.

(f) Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Adhere, staple, and seal. Extend patch at least 50 mm in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.

3 Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 50 mm below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.

4 Exterior Wall Penetrations: For penetrations of below grade exterior walls, extend metal jacket for exterior insulation through penetration to a point 50 mm from interior surface of wall inside the building. Seal end of metal jacket with vapor barrier coating. Secure metal jacket ends with metal band. At point where insulation metal jacket contacts mechanical sleeve seal, insert cellular glass preformed pipe insulation to allow sleeve seal tightening against metal jacket. Tighten and seal sleeve to jacket to form a watertight seal.

5 Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions. Apply an aluminum jacket with factory-applied moisture barrier over insulation. Extend 50 mm from both surfaces of wall or partition. Secure aluminum jacket with metal bands at both ends. Seal ends of jacket with vapor barrier coating. Seal around penetration with joint sealer.

6 Fire-Rated Walls and Partitions Penetrations: Terminate insulation at penetrations through fire-rated walls and partitions. Seal insulation ends with vapor barrier coating. Seal around penetration with fire stopping or fire-resistant joint sealer. Refer to “Joint Sealants” for fire stopping and fire-resistant joint sealers.

7 Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.

8 Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with vapor barrier coating. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive. Use same material and thickness as adjacent pipe insulation. Overlap nesting insulation by 50 mm or 1-pipe diameter, whichever is greater. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape. Insulate elbows and tees smaller than 80 mm pipe size with premolded insulation. Insulate elbows and tees 80 mm and larger with premolded insulation or insulation material segments. Use at least 3 segments for each elbow.

9 Cover insulation, except for metal-jacketed insulation, with 2 layers of lagging adhesive to a minimum thickness of 1.6 mm. Install glass cloth between layers. Overlap adjacent insulation by 50 mm in both directions from joint with glass cloth
and lagging adhesive.

10 Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. Install saddles, shields and inserts as specified in Section 19 part "Hangers and Supports". For cold surface piping, extend insulation on anchor legs a minimum of 300 mm and taper and seal insulation ends.

11 Glass Fiber Pipe Insulation Installation: Bond insulation to pipe with lagging adhesive. Seal exposed ends with lagging adhesive. Seal seams and joints with vapor barrier compound.

19.3.4 Jackets

1 Interior Exposed Insulation: Install continuous aluminum jackets only for piping in plant room.

2 Exterior Exposed Insulation: Install continuous aluminum jackets and seal all joints and seams with waterproof sealant.

3 Install metal jacket with 50 mm overlap at longitudinal and butt joints. Overlap longitudinal joints to shed water. Seal butt joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel draw bands 30 mm on center and at butt joints.

19.3.5 Applications

1 Piping Systems: Unless otherwise indicated, insulate the following piping systems:
   (a) Domestic hot water

2 Equipment: Unless otherwise indicated, insulate the following indoor equipment.
   (a) Domestic hot water equipment, tanks, and water heaters

19.3.6 Pipe Insulation Schedules

1 General: Abbreviations used in the following schedule include:
   (b) Pipe Sizes: NPS - Nominal Pipe Size.

2 Interior Domestic Hot Water

<table>
<thead>
<tr>
<th>PIPE</th>
<th>MATERIALS</th>
<th>THICKNESS</th>
<th>VAPOUR BARRIER</th>
<th>FIELDAPPLIED JACKET*</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-80</td>
<td>Glass Fiber</td>
<td>25</td>
<td>Yes</td>
<td>K</td>
</tr>
</tbody>
</table>

* Except for mechanical rooms where aluminum applied jacket is required.
20. **PLUMBING WORKS**

20.1 **GENERAL**

20.1.1 **Related Documents**

1. Drawings and general provisions of Contract, including General Condition, Conditions of Particular Application, apply to work of this section.

20.1.2 **Description of Work**

1. This section covers the work of water supply and drainage systems as required by the Contract.

2. **Domestic Water Supply Systems:** Provide Main water meters with, connection to site main include pipework therefrom to inside the buildings.

3. Provide cold and hot water supply piping including valves, hangers and supports, expansion joints/loops, regulating valves, automatic air vents, drain valves, insulation, wrapping, excavation, dewatering, and backfill.

4. Provide hot water system, including pipework, controls, electrical water heaters, and safety devices.

5. Provide system testing, disinfection, and commissioning.

6. **Drainage System:** Provide domestic soil and waste, and vent drainage system to collect soil borne wastewater from sanitary fixtures, wastewater from wet areas and equipment.

7. Provide above ground and underground piping, hangers and supports, floor drains, cleanouts, roof drains, trap primer, vacuum breakers, plumbing fixtures and fittings, excavation, dewatering, pipe bedding and surroundings and backfill.

8. Provide retarding chamber, sump pumps for under gravity floor drainage.

9. Provide storm water system to collect rain water on the roof and connect to the nearest sokaway.

10. Provide system testing and commissioning.

11. **Existing Tie Point:** The contractor shall connect the water supply and drainage pipe line from inside building to existing tie in point.

20.1.3 **REFERENCE STANDARDS AND CODES**

1. Comply with the stipulations of the latest Edition of the applicable British Standard Specifications, with The chartered institution of building services Engineers; guide book, and the Qatar Construction specification rules and regulations guide for plumbing and drainage works, and other equivalent International Standards, by-laws and regulations of all statutory authorities concerned.
2  British Standard Specifications

3  BS No.
   (a) 4504  Flanges and Bolting for Pipes, Valves and Fittings. Metric Series
   5154  Copper alloy globe, stop and check valves for general purposes.

20.1.4 Related Sections

1  The following works include requirements which relate to this section:
   (a) Excavation Support and Protection
   (b) Earthwork
   (c) Metal Fabrication
   (d) Painting

2  Plumbing Specification Sections.

20.1.5 Submittals

1  Submit in accordance with the requirements of general conditions of contract the followings:
   (a) Product Data:  Submit manufacturer’s technical product data for materials and products.
   (b) Shop Drawings:  Submit (1:20, 1:50 and 1:100) scaled layout drawings of plumbing pipes and fittings including, but not necessarily limited to, pipe sizes, locations, elevations and slopes of horizontal runs, wall and floor penetrations and connections. Show interface and spatial relationship between piping and proximate equipment. Obtain Engineer’s approval prior to the commencement of work. Alterations in shop drawings from Contract Drawings, whether due to coordination or otherwise, shall be carried out by the Contractor.
   (c) Coordination Drawings:  Drawn accurately to 1:50 scale and coordinating penetrations and system requirements with other trades.
   (d) Record Drawings:  At project close-out, submit record drawings of installed systems.
   (e) Maintenance Data:  Submit maintenance data and parts lists for plumbing systems, materials and products. Include this data, product data, shop drawings and record drawings in operation and maintenance manual.
   (f) Samples:  Submit samples for the Engineer’s approval.

20.1.6 Quality Assurance

1  Manufacturer’s Qualifications:  Firms regularly engaged in manufacture of plumbing systems products of types, materials and sizes required and whose products have been in satisfactory use in similar service for not less than 15 years.

2  Contractor Engineer’s Qualifications:  Graduated mechanical engineer with
experience of not less than 10 years in the plumbing fields for projects of similar nature and size.

20.1.7 Nominal Pipe Sizes (NPS)

1 Pipe diameters indicated on the Drawings are nominal. Exact pipe diameters are understood to be the exact pipe diameters as per the applicable specified standard for each pipe material.

20.2 PRODUCTS

20.2.1 Materials and Products

1 Provide equipment, piping materials and factory-fabricated piping products of sizes, types, pressure ratings and capacities as indicated. Where not indicated, provide proper selection to comply with installation requirements. Provide sizes and types matching piping and equipment connections. Provide fittings of materials which match pipe materials used in plumbing systems. Where more than one type of materials or products are indicated, obtain Engineer’s clarification prior the procurement of materials.

20.2.2 Basic Identification

1 Provide identification in accordance with the following listing:

(a) Valves: White plastic identification labels with black letters indicating valve type, number and service.
(b) Above Ground Piping: Plastic pipe markers/colour coded paint.
(c) Underground Piping: Underground-type plastic pipe markers.
(d) Comply with ASME A13.1 for colour coding.

20.2.3 Plumbing Piping

1 Pipes and fittings are specified in different sections of Plumbing specs. The listing for the utilization of the various materials for plumbing works are indicated on the table attached to the end of this section.

20.2.4 Interior Automatic-Air Vents

1 Float type hot pressed brass MS 58 consists of two halves screwed together and fitted with O-ring seal, with rubber valve seal, plastic float, vacuum breaker complete with automatic self-sealing spring-loaded brass check valve, stainless steel spring and catch ring rated for 1 000 kPa working pressure.

20.2.5 Protective Wrappings

1 Non-woven fabric carrier free from chemical impurities, fully impregnated and coated on both sides with neutral compound based on saturated petroleum hydrocarbons with inert siliceous filter tape.
20.2.6 Water Meter

1. Register in cubic meter, AWWA C 700, displacement (disc) type, displacement (disc) type, equipped with digital flow converter device, with bronze main case, complete with isolating valves, check valve, strainer and cabinet.

20.2.7 Water Meter Cabinets

1. Steel cabinet, 2 mm thick with continuous type hinge 3 mm thick steel door with identifying letters engraved to door “Water Meter”. Size the cabinet to house inlet pipe connection, strainer, valves, meter and outlet pipe connection. Include door operating hardware in stainless steel with cam-action latch. Cabinet shall be manufactured with corners mitred, welded and ground smooth. The cabinet should be as per KAHRAMAA requirements.

20.2.8 Escutcheons

1. Chrome plated heavy brass of sufficient diameter to amply cover up the sleeved opening.

20.2.9 Interior Wall Pipe Sleeves

1. Standard weight galvanized steel pipe sleeve of size to pass pipe and insulation.

20.2.10 Exterior Wall Pipe Sleeves

1. Standard weight galvanized steel pipe sleeve with sealing and anchoring collar poured in place.

20.2.11 Rocker Pipe

1. Two adjacent flexible pipe joints, one is located at a distance of 150 mm from the external face of the structure and the second is located at a maximum distance of 300 mm.

2. Provide the two flexible joints at each side of the building boundary and at expansion joints.

20.2.12 Angle Stop Valves

1. Chrome plated, zinc free bronze angle stop valves and escutcheon, marked red for hot water and blue for cold water.

20.2.13 Group Valves

1. Embedded Valves: Bronze body with pre-assembled head part 15 mm short spindle with chrome plated handle assembly, screw flange with wall sealing,

2. Concealed Valves: Bronze gate valves as specified in section 19 part (Valves for Plumbing Works).

20.2.14 Inspection Chamber

1. Shall be cast-in-situ circular concrete inspection chamber with dimensions as
indicated in drawings and depth as required.

2. Internal and external protective coating shall be as specified in Specification Sections.

3. Provide heavy duty ductile iron double seal cover and frame conforming to BS & Qatar Specifications. Install frame so tops of covers are flush with surface of adjoining pavement. Ground surface inspection chamber steps shall be ductile iron with protective coat tar epoxy coating.

4. Stops shall be installed with manner to provide a continuous vertical ladder from the manhole rim to the top surface of the bottom slab at intervals of 300 mm and shall be installed in a manner to be capable of withstanding a force of 160 kg applied on the stops.

20.2.15 Retarding Chambers

1. Cast-in-place concrete rectangular chamber of size according to dimension as shown on Drawings.

2. Bituminous coating shall be applied to inside surfaces.

3. Chamber covers and frames shall be heavy duty ductile iron conforming to British standard Qatar Specifications.

4. Steps, if required, shall be fabricated from carbon steel bars of diameter, shape, details and spacing as shown on Drawings.

5. Steps shall be painted with three approved coats of epoxy coating.

6. Concrete work shall be as per Structural Specs”.

20.2.16 GRP Insulated Tanks

1. The water storage tanks shall be made of sectional glass fiber reinforced polyester panel construction suitable for potable water and resistant to ultra violet rays. Tank shall not encourage the growth of algae and shall have a smooth internal surface for easy cleaning.

2. The GRP panels shall be insulated with foamed urethane and shall support 80 °C radiation temperatures.

3. Raw material for water tank panels shall contain long continuous strand fiber to provide high strength. Sealing material between panels shall be high quality for potable water. Assembly bolts & nuts shall be high strength stainless steel 316 type. No Internal bracing & Only external flanged reinforcement is allowed. Tank dimensions shall be as indicated on the drawings. Each tank shall contain external ladders 2 nos (Steel with hot dip galvanized coating), internal ladders 2 nos (PVC) and manholes Ø 600 mm 2 nos. Tank shall include air vent size 100 mm dia and 210 mm height x 2 no. The Tank shall be supported on steel skid base members with size at least 125 x 65 x 6 mm and supporting reinforced concrete beams with min. dimensions 500 x 300 x 3 Nos. to suit tank dimensions.

4. After installation, tanks shall be filled with water for testing for 24 hours. No
leakage shall be observed at joints. On completion of leak tests, the tank shall be flushed out twice using maximum water pressure available and all extraneous matter removed including the water used during the operation. The whole of the installation shall be guaranteed for a period of 10 years. Any defect/damage or leakage occurred during the guarantee period shall be made good by the Contractor at no cost to the Client.

20.2.17 Water Tank Air Vent

1. Cast iron double arm swan-neck pattern with opening covered with plain weave copper mesh constructed from 0.355 mm copper wire and having 20 wires per inch.

20.2.18 Water Tank Level Indicators

1. Audible and visual indicator/alarm panel including the following features and functions:
   
   (a) High water level audible alarm and visual indication - First low level audible alarm and visual indication - Second low level pump cut-out and indication - Remote indication contactors.
   
   (b) Mercury level regulators constructed from polypropylene with enclosed mercury switch activated by tilting and electrically connected to the water level indicator panel.
   
   (c) The signals of water tank levels shall be transferred to BMS domestic water tank.
   
   (d) The Contractor shall provide all required devices, controllers and selected BMS compliant products according to the input/output data point summary schedules. Coordinate with BMS supplier to ensure compatibility, integrity and network connectivity using TCPL±P protocol.

20.2.19 Fuel Oil Supply and Storage System

1. Provide a complete fuel supply oil system comprising fuel oil storage steel tanks, fuel transfer pumps, rotary drum pump and all piping valves, strainers and necessary accessories to transfer the fuel oil and control the system.

2. The fuel storage tanks shall be carbon steel fabricated in accordance to UL 80, NFPA 31 and Woqod requirements, the location is indicated on the Drawings. The tanks shall be surrounded by bund walls in all sites and buried in Shamal Site, as detailed indicated.

3. The tank shall be cylindrical shape and provided with filling pipe connection, vent connection, pump adaptors, manways and drain valves, fuel oil discharge line complete with necessary valves, piping and fittings, glass level indicator with steel guard and pit cocks.

4. Pump discharge head and manifold assembly are grey iron accordance to ASTM A98 Class 30.

5. Hardened steel shaft, mechanical seal the pump shall be provided with pressure relief valves, gate and check valves, motor and control panel, the pump capacity
shall be as indicated on equipment schedule drawing for each site; The capacity of the pump and head shall be rechecked/coordinated/calculated then submitted for review/approval.

6 The fuel oil transfer pumps shall be installed outside the fuel oil storage tank and arranged so that one pump in duty and the other pump as stand-by.

7 The pumps shall be controlled by level sensors in daily fuel tank and monitored from fuel oil system control panel.

8 The control panel shall be provided with alternator to operate two pumps in sequence of operating/stand-by.

9 The system shall be provided with hand pump on by pass of fuel oil discharge pipe. The hand pump shall be rotary type, self priming, cast iron body, with crank handle and replaceable vanes.

10 The fuel oil supply system piping shall be black steel Schedule 40, in accordance with ASTM A 53, Type S (Seamless), Grade A.

11 The fuel supply pipeline to be connected from the fuel oil pumps to daily fuel tank of stand-by generator sets.

20.2.20 Painting

1 Comply with Qatar regulations and the engineer.

20.3 EXECUTION

20.3.1 Inspection

1 Examine substrates and conditions under which soil and waste systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

20.3.2 Installation of Basic Identifications

1 Install identification for surfaces requiring painting, insulation or other covering finish, including valve tags, after completion of covering and painting. Install identification prior to the installation of acoustical ceilings and similar removable concealment.

2 Apply colour coding paint for piping and equipment.

3 Install plastic pipe marker on each system indicated to receive identification and include for arrows to show normal direction of flow.

4 Install, during backfilling of each exterior underground piping system, continuous underground type plastic line marker located directly over buried line at 150 to 200 mm below finished grade.

5 Provide valve tag on every valve, cock and control device in each piping system. Exclude check valves, valves within factory fabricated equipment, hose bibs and shut-off valves at plumbing fixtures. List each tagged valve in valve schedule for
each piping system.

20.3.3 Installation of Above Ground Piping

1. Drawings indicate general location and arrangements of piping systems. Install piping, as far as practical, as indicated taking into consideration pipe sizing and friction loss, expansion, equipment sizing, other trades and other design requirements.

2. Ream ends of pipes and remove burrs. Bevel plain ends of pipe. Remove scale, slag, dirt and debris for both inside and outside of piping and fittings before assembly.

3. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings and below grade or floors unless indicated otherwise.

4. Install piping free from sags or bends and with ample space between piping to permit proper insulation.

5. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted unless expressly indicated on Drawings.

6. Locate groups of pipes parallel to each other and spaced to permit applying full insulation and servicing of valves.

7. Install drains at low points in mains, risers, and branch lines consisting of tee fittings, 15 mm ball valve and short 15 mm threaded nipple and cap.

8. Seal pipe penetrations through exterior walls using sleeves or puddle connections.

9. Install unions adjacent to each valve and at final connection to each piece of equipment and plumbing fixtures having 50 mm and smaller.

10. Install flanges in piping 65 mm and larger, where indicated, every 12 meter, adjacent to each valve and at each of the final connection to each piece of equipment.

11. Carry out, where applicable, pipework as building proceeds as soon as possible to minimize cutting away and repairing.

12. Mark out correctly the positions of necessary holes in walls, floors, ceilings, etc., for pipes and pipe supports.

20.3.4 Installation of Underground Piping

1. Install underground piping as indicated and in accordance with National Standard Plumbing Code, BS & Qatar Regulations. Lay underground piping beginning at low point of systems and true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer’s recommendations for use of lubricants, cements, and other special installation requirements. Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in ends of
uncompleted piping at end of day or whenever work stops. Terminate underground piping at 600 mm above finish floor, coordinate those termination locations to be coordinated with aboveground stacks, plumbing fixtures, etc.

2. Apply two layers, overlapped 50%, of approved tape as recommended by pipe manufacturer to be compatible with pipe material. Use minimum 500 microns thick and 100 mm wide inner layer. Use 750 microns thick and 100 mm wide outer layer.

20.3.5 Excavation and Backfill

1. Excavation: Make pipe trench true and even to falls, trim and ram trench bottom to correct level. Refer to “Earthworks”.

2. Dewatering: Provide necessary equipment for dewatering while erecting, testing underground piping.

3. Planking and Strutting: Provide adequate shuttering by skilled carpenters. Remove timber as backfilling proceed.

4. Backfill: Use only approved backfill as specified in “Earthwork”.

5. Do not carry out backfill prior the approval of pipe testing. Apply backfill in compacted layers of no more than 300 mm thick. Compact each layer to 97% of maximum dry density as specified in “Earthwork”.

20.3.6 Installation of Hangers and Supports

1. Install hangers, supports, clamps and attachments to support piping properly from building structure and arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Install hangers and supports to provide piping slopes.

20.3.7 Installation of Drainage Products

1. Cleanouts: Install in piping as indicated, as required by National Standard Plumbing Code, BS & Qatar regulations; and at each change in direction of piping greater than 45°; at maximum intervals of 15 m for piping 100 mm and smaller and 30 m for larger piping; and at base of each vertical soil or waste stack located 150 mm above the Flood Rim of the lowest fixture on the lowest floor. Install floor and wall cleanout covers for concealed piping, select type to match adjacent building finish.

2. Flashing Flanges: Install flashing flange and clamping device with each stack, floor drain, and cleanout passing through waterproof membranes.

3. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer’s instructions.

20.3.8 Equipment Connections

1. Provide soil and waste piping runouts to plumbing fixtures and drains, with
approved trap, of sizes indicated; but in no case smaller than required by National Standard Plumbing Code.

20.3.9 Final Electrical Connections

1. Provide main isolators in control panels of each equipment.

2. Carry out electrical connection to control panel isolators, between control panel and equipment including control wiring. Carry out earthing for electrical equipment. Comply with the requirements of electrical specs requirements.

20.3.10 Pipe Sleeves

1. Install sleeves in connection with piping passing through slabs, partitions or the other building construction.

2. Set sleeves in new concrete construction before pouring.

3. Provide sleeves for vertical pipes in open chases or shafts, where allowances for expansion are required or where chases or shafts are to be grouted in after work is installed.

4. For interior wall sleeves terminate sleeve flush with wall.

5. Seal sleeves through walls with tightly packed mineral fiber. Special consideration shall be given to the sealing of fire walls.

6. Use escutcheons flush against finished walls for piping exposed to view.

7. For exterior wall sleeves coat exterior surface of pipe and sleeve with waterproofing material. Seal sleeve through wall with tightly packed waterproofing material. Coat exterior surfaces with tar compound.

8. Provide fire stopping to sleeves passing through floors, fire protected shaft walls and fire rated walls. Provide fire stopping for the complete sleeve length.

20.3.11 Field Quality Control

1. Test piping systems in the presence of the Engineer in accordance with requirements of The chartered institution of building services Engineers, and National Standard Plumbing Code and as specified. Correct defects appearing under test and repeat until no defects are disclosed. Replace defective work with new work without extra charges to the Employer.

2. Apply hydraulic leakage test for gravity drainage pipes both in its entirety and in sections after rough piping installation. When applied to entire system, close tightly openings in the piping except highest opening and fill the system with water to point of overflow. When tested in sections, plug tightly pipe openings except the highest opening of the section under test. Fill each section with water but no section shall be tested with less than 3 meters head of water. In testing successive sections, test at least the upper 3 meters of the next to preceding section. Keep the water in the system or in the portion under test for at least 15 minutes before inspection starts the system shall be tight closed at all points.
3 Apply hydraulic pressure test for other piping, as the work proceeds, of no less than 1 ½ times the working pressure of the system. Maintain the pressure for one hour. Apply hydraulic pressure test of twice the working pressure for underground pipelines.

4 Test the whole piping systems of each service immediately prior the completion of work.

5 Test all fixtures for soundness, stability of support and satisfactory operation.

6 Test each piece of sanitary ware as follows:
   (a) Flush water closets twice and check for leaks and defects.
   (b) Fill lavatories and sinks to the over flow level, and after running the water through the overflow for a minimum of 30 seconds, remove the plug. Check for leaks and defects.

7 Repair any defects or leaks. Replace cracked or chipped fixtures.

20.3.12 Cleaning, Flushing and Disinfection

1 Clean, flush and disinfect entire water supply system, including tanks, equipment, etc., using either calcium or sodium hypochlorite solution. The following process shall be followed:
   (a) Flush thoroughly piping with clean potable water to remove dirt and other contaminants. Remove screens of taps before flushing and reinstall them after completion of disinfection.
   (b) Inject disinfecting agent by means of proportioning pump at an even rate.
   (c) Open sectional valves and ensure that each outlet shall be opened at least twice during disinfection. Check residual with ortholidin solution.
   (d) Close and secure all outlets when the chlorine residual concentration, at all outlets, indicates no less than 50 ppm calculated on the volume of water contained in piping.
   (e) Retain the residual chlorine in the piping system for a period of no less than 24 hours. Ensure that the residual, after retention period is not less than 5 ppm. If not, repeat the process.
   (f) If found satisfactory, flush the piping with clean potable water until residual chlorine at outlets are not greater than the incoming water supply.
   (g) Employ approved applicators or qualified personnel with chemical and laboratory experience to perform and certify the process.

2 Indicate, in the certificate of performance, the following:
   (a) Name and location of the job and date of disinfection performance
   (b) Material used for disinfection and its concentration
   (c) Retention period of disinfection in piping system
   (d) ppm chlorine during retention
(e) ppm chlorine after flushing
(f) Statement of compliance with the specification
(g) Signature and address of company/person performing disinfection
(h) Under no circumstances permit the use of any portion of the water supply piping till the completion of proper and certified disinfection and flushing is terminated.

20.3.13 PROTECTION

1 Protect piping during remainder of construction period to avoid clogging with construction materials and debris and to prevent damage from traffic and construction work.

20.3.14 PIPING MATERIAL

<table>
<thead>
<tr>
<th>System</th>
<th>Pipe Size</th>
<th>Internal Works</th>
<th>Site Works Till the Connection Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Above Ground</strong></td>
<td><strong>Underground</strong></td>
</tr>
<tr>
<td>Drainage</td>
<td></td>
<td>Soil Waste and Vent Piping (Internal Works)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 mm</td>
<td>Polypropylene</td>
<td>Polypropylene, gravel bed and sand surrounding</td>
</tr>
<tr>
<td></td>
<td>and larger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory &amp; Kitchen Waste</td>
<td>50 mm</td>
<td>Polypropylene</td>
<td>Polypropylene</td>
</tr>
<tr>
<td></td>
<td>and larger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Main</td>
<td>80 mm</td>
<td>Pressurized UPVC</td>
<td>Pressurized UPVC</td>
</tr>
<tr>
<td></td>
<td>and larger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Cold Water</td>
<td>75 mm</td>
<td>Copper pipes table (x)</td>
<td>Copper pipes table (y), wrapped, sand bed, &amp; surroundings</td>
</tr>
<tr>
<td></td>
<td>and smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic hot Water and Hot water return</td>
<td>75 mm</td>
<td>Copper pipes table (x), Insulated</td>
<td>Copper pipes table (y), Insulated, wrapped, sand bed, &amp; surroundings</td>
</tr>
<tr>
<td></td>
<td>and smaller</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Use mechanical joints
(b) Unless otherwise indicated on drawings.
21. **DOMESTIC WATER BOOSTER PUMP SET**

21.1 **GENERAL**

21.1.1 **Related Documents**

1. Drawings and general provision of the Contract, including the General Conditions, Conditions of Particular Application apply to this Section.

21.1.2 **Description of Work**

1. This section includes the domestic water booster pump set.

21.1.3 **Related Sections & Works**

1. The following sections contain requirements that relate to this section:

   2. Section “Electrical Requirements for Mechanical Equipment”.

   3. Sections for piping not specified in this section.

   4. Electrical Specs for power-supply wiring, field-installed disconnects required electrical devices, and motor controllers.

21.1.4 **Submittals**

1. Submit the following according to the Conditions of the Contract and all Specification Sections.

   2. Product Data including certified performance curves, system curve, weights (shipping, installed, and operating), furnished specialties, pressure vessel sizing calculation and accessories. Include startup instructions.

   3. Shop Drawings showing layout and connections for pumps. Include setting drawings with templates, directions for installation, foundation and anchor bolts, and other anchorage.

   4. Wiring Diagrams detailing wiring for power, signal, and control systems differentiating between manufacturer-installed wiring and field-installed wiring.

   5. Product Certificates signed by pump manufacturers certifying accuracy under specified operating conditions and compliance with specified requirements.

   6. Maintenance Data for each type and size pump specified to include the Operating and Maintenance Manual.

21.1.5 **Quality Assurance**

1. Comply With Provisions of the ASME B 31.9 “Building Services Piping” for piping materials and installation H.I. “Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps” for pump design, manufacture, and installation, moreover the requirements of the Qatar Construction specification rules and regulations guide for plumbing and drainage works.
2 NEMA MG 1 “Standard for Motors and Generators” for electric motors. Include requirements of NFPA 70 “National Electrical Code” for electrical components and installation.

3 Single-Source Responsibility: Obtain same type of pumps from a single manufacturer with motors, control panel, valves, components, pressure vessel, and accessories all on common base from a single source. The pressure vessels may be dispatched independent and installed in the site. Include responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

4 Design Criteria: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Engineer. The burden of proof for equality of pumps is on the proposer.

21.1.6 Delivery, Storage and Handling

1 Store pumps in a clean, dry location, retain shipping flange protective covers and protective coatings during storage and protect bearings and couplings against damage from sand, grit, or other foreign matter.

2 For extended storage, greater than 5 days, internal parts shall be dried with hot air or a vacuum-producing device. After drying, Contractor shall coat internal parts with light oil or kerosene. Contractor shall dismantle bearings and couplings, dry and coat with acid-free heavy oil, and tag and store in a dry location.

3 Comply with pump manufacturer’s rigging instructions for handling.

21.2 PRODUCTS

21.2.1 Manufacturers

1 Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal.

21.2.2 Pumps, General

1 Factory assembled and tested pumps of construction required for permanent installation with single NEMA MG 1 or IEE speed with type of enclosure and electrical characteristics indicated. Built-in thermal-overload protection and grease-lubricated ball bearings shall be included. Motors are non-overloading within full range of pump performance curves.

2 Apply manufacturer’s finish paint to factory-assembled and-tested pump sets prior to shipping. The Engineer shall approve paint color.

3 Manufacturer’s Preparation for Shipping: Clean flanges and exposed-machined metal surfaces and treat with anticorrosion compound after assembly and testing. The Contractor shall protect flanges, pipe openings and nozzles with wooden flange covers or with screwed in plugs.
21.2.3 Domestic Water Booster Set

1 The potable Water booster pump set shall be a completely packaged factory assembled and tested unit complete with all major components, instruments, safety devices, automatic back-wash filter, stop-valves and pre-wired control panels.

2 Potable water booster pump set Fully automatic package, constant pressure outlet, two pumps intermittent duty lifting set complete with related pipe work, isolating, check and regulating valves, sustaining pressure valves, pressure gauges, pressure switches, and control panel, prewired and assembled on common base frame. The Contractor shall arrange the set so as each pump rated for 100% of total peak flow rate, one pump in operation and the other pump stand by. The pump set with all accessories, control and safety devices shall be provided to give the required performance.

3 The unit shall provide water, within a range of pressures specified or required. The pumps operation shall be controlled by pressure switch mounted on discharge line.

4 For dry run prevention of the pump, following shall be provided.

5 Plastic float with micro switches to stop the pump when water level reaches preset low level in the storage tank.

6 A flow sensor in the suction line to stop the pump if 'no-flow' status is sensed.

7 The control panel shall incorporate all starters, pilot lights, fuses and circuit breakers, relays and automatic change over equipment to automatically start the standby pump on failure of the selected duty pump. A selector switch to allow pump to operate as duty pumps shall be fitted. An interlocked handle shall isolate the panel when the door is opened. Cyclic changeover facility shall also be provided.

8 Pumps: Vertical multi-stages stainless steel.

9 Casings: Stainless steel.

10 Impeller: Stainless steel statically and dynamically balanced, closed, single suction keyed to shaft and secured by locking cap screw.

11 Pump Shaft and Sleeve: Stainless steel shaft.

12 Pump Bearings

(a) The pump bearings shall be designed to absorb any axial thrust forces produced by the impeller to ensure that axial forces are not transmitted to the drive couplings.

(b) Bearings shall be either bush type with oiling ring and reservoir, bush type with oil impregnated material, or ball or roller bearings with oil or grease lubrication. Oil reservoirs shall be fitted with content indicator and drain plug. Greased bearings shall have grease nipples, or screw down auto lubricators provided in accessible positions.
13 Seals: Self-adjusting mechanical seal, with carbon /ceramic seats.

14 Drive Couplings

(a) An approved pattern of resilient drive couplings shall be installed between

(b) the prime mover and the pump shaft. The couplings shall be designed to
absorb stresses caused by minor misalignment of the motor and pump
shafts and to minimize the transfer of vibration.

(c) The couplings shall be capable of being disconnected easily to facilitate
dismantling for pump or motor overhaul.

15 Motors: TEFC squirrel-cage motors, Class F insulation.

16 Controller: Dust and vapor-proof painted steel enclosure, housing pumps and
controls with, but not limited to, the following features:

(a) Main circuit breaker

(b) Auto rotation of duty pumps

(c) Omission of faulty pump from rotation cycle

(d) Adjustable start time delays

(e) Adjustable run on time delays

(f) Low water-level cut-out circuitry (no flow)

(g) Hand/Off/Auto switch for each pump

(h) Visual LED display and volt free output contacts for run and tripped pumps
and for low water level.

(i) Power-on lights

(j) Duty selector switch

(k) Control circuit fuses

(l) Pumps starters

(m) Alternator

(n) Thermal overload switch

17 The following signals shall be transferred to the BMS domestic water booster
pump set:

(a) Start/stop

(b) On/off

(c) Manual/fault

18 The contractor shall provide all required instrumentations, control devices and
selected BMS compliant products according to the input/output data point
summary schedules. Coordinate with BMS suppliers to ensure compatibility,
integrity and network connectivity using TCPL + P protocols.

19 Base Frame: Painted welded fabricated mild steel sections suitable for the
attachments of vibration isolation, relief valve, sight gauge, pressure switches and drain valves.

21.3 EXECUTION

21.3.1 Examination

1 Examine area equipment, foundations and conditions for compliance with requirements for installation and other conditions affecting performance of pumps. The installation shall not proceed until unsatisfactory conditions have been corrected.

2 Examine roughing-in of piping systems to verify actual locations of piping connections prior to pumps installation.

21.3.2 Equipment Bases

1 Construct concrete equipment pads as follows:

(a) Concrete pads are to be formed by using lumber with form release compounds, top edge and corners of pad are to be chamfered.

(b) Reinforcing bars are to be installed tied to frame and anchor bolts and sleeves are to be placed using manufacturer's installation template.

(c) Concrete is to be placed and allowed to cure before installation of pumps. Portland cement will be used, 300-kPa compressive strength after 28 days and normal weight aggregate.

21.3.3 Installation

1 Comply with the manufacturer's written installation and alignment instruction. Pump set shall be installed in location indicated and arranged to provide access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

2 Pump set and piping shall be supported separately so that the weight of the piping system does not rest on the pump.

3 Pump set shall be set on rectangular metal blocks and shims or on metal wedges having a small taper at points near foundation bolts to provide a gap of 20 mm to 40 mm between pump base and foundation for grouting. Metal supports or wedges shall be adjusted until shafts of pumps and drivers are level. The coupling faces and suction and discharge flanges of each pump shall be checked to verify that they are level and plumb.

4 Plumb pump and motor shafts and align piping connections after setting on foundations, after grout has been set and foundation bolts have been tightened and after piping connections have made.

21.3.4 Connections

1 Install valves that are same size as the piping connected to the pump. Suction and discharge pipe sizes shall be installed equal to or greater than the diameters of the pump nozzles.
2 Non-slam checks valve and globe valve shall be installed on the discharge side of each pump. Gate valve and strainer shall be installed on the suction side of each pump.

3 Flexible connectors shall be installed on the suction and discharge side of each pump. Flexible connectors shall be located between the pump casings and discharge valves and upstream the pump suction connection.

4 The Contractor shall install pressure gauge connector plugs in suction and discharge piping at each pump with petcock.

5 The Contractor shall install electrical wiring and make connections to the pump controllers and there from to the motors including control wiring and connections.

21.3.5 Field Quality Control

1 Suction line connections shall be checked for tightness to avoid drawing air into pumps. Strainers on pump suction piping should be cleaned. Pump controls shall be set for automatic start, stop and cut out operations as required for system applications.

21.3.6 Commissioning

1 The following preventative maintenance operations and checks shall be performed before start-up:

   (a) Lubrication of oil-lubricated bearings;
   (b) Removal of grease-lubricated bearing covers and flushing the bearings with kerosene and thoroughly clean. The Contractor shall fill with new lubricant in accordance with the manufacturer’s recommendations;
   (c) Disconnection of coupling and checking motor for proper rotation. Rotation shall match direction of rotation marked on pump casing;
   (d) Checking that pump is free to rotate by hand. If the pump is bound or even drags slightly, the pump shall not be operated until the cause of the trouble is determined and corrected;

21.3.7 Starting Procedure

1 Starting procedure for pumps with shutoff power not exceeding the safe motor power shall be as follows:

   (a) The Contractor shall prime the pump by opening suction valve and closing drains, and prepare the pump for operation.
   (b) The Contractor shall open the valve in the cooling water supply to the bearings where applicable
   (c) Motor shall be started and the discharge valve shall be opened slowly
   (d) The Contractor shall check the general mechanical operation of the pumps, motors and the system

2 When pumps to be started against closed check valves with discharge globe valves open, steps are the same except open discharge globe valves some time
before motors are started.

21.3.8 Spare Parts

1. Hand over to the Employer the spare parts and tools required for operation and maintenance as recommended by the manufacturer to cover a working period of two years. In addition, submit to the Employer, for approval, a priced list of the above recommended spare parts and tools for an additional period of three years. The list should nominate the above-required items. The approved list shall be part from the operation and maintenance manuals.

21.3.9 Data Sheet

1. For Each Site of the five sites domestic pumps equipment data sheet details and exact locations; kindly refer to both different sites drawings and the equipment’s schedule on the following drawings:

(a) Al Shamal Site : Dwg. No. P-51-601.
22. VARIABLE SPEED DOMESTIC WATER BOOSTER PUMP SET

22.1 GENERAL

22.1.1 Related Documents

1 Drawings and general provision of the Contract, including the General Conditions, Conditions of Particular Application and Division 1 Specification Sections, apply to this Section.

22.1.2 Description of Work

1 This section includes the domestic water booster pump set.

22.1.3 Related Sections

1 The following sections contain requirements that relate to this section:

2 Section 19 part 1 “Electrical Requirements for Mechanical Equipment”.

3 Division 21 Sections for power-supply wiring, field-installed disconnects required electrical devices, and motor controllers.

22.1.4 Submittals

1 Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

2 Product Data: including certified performance curves, system curve, weights (shipping, installed, and operating), furnished specialties, pressure vessel sizing calculation and accessories. Include startup instructions.

3 Shop Drawings: showing layout and connections for pumps. Include setting drawings with templates, directions for installation, foundation and anchor bolts, and other anchorage.

4 Wiring Diagrams: detailing wiring for power, signal, and control systems differentiating between manufacturer-installed wiring and field-installed wiring.

5 Product Certificates: signed by pump manufacturers certifying accuracy under specified operating conditions and compliance with specified requirements.

6 Maintenance Data: for each type and size pump specified to include the “Operating and Maintenance Manual” specified in Division 1 Section “Project Closeout”.

22.1.5 Quality Assurance


2 NEMA MG 1 “Standard for Motors and Generators” for electric motors. Include
requirements of NFPA 70 "National Electrical Code" for electrical components and installation.

3 Single-Source Responsibility: Obtain same type of pumps from a single manufacturer with motors, control panel, valves, components, pressure vessel, and accessories all on common base from a single source. The pressure vessels may be dispatched independent and installed in the site. Include responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

4 Design Criteria: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Engineer. The burden of proof for equality of pumps is on the proposer.

22.1.6 Delivery, Storage and Handling

1 Store pumps in a clean, dry location, retain shipping flange protective covers and protective coatings during storage and protect bearings and couplings against damage from sand, grit, or other foreign matter.

2 For extended storage, greater than 5 days, internal parts shall be dried with hot air or a vacuum-producing device. After drying, Contractor shall coat internal parts with light oil or kerosene. Contractor shall dismantle bearings and couplings, dry and coat with acid-free heavy oil, and tag and store in a dry location.

3 Comply with pump manufacturer's rigging instructions for handling.

22.2 PRODUCTS

22.2.1 Manufacturers

1 Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal.

22.2.2 Pumps, General

1 Factory assembled and tested pumps of construction required for permanent installation with TEFV, 400/3/50 V, high efficiency motor and IP55 enclosure variable speed drive, which shall be integrated with the motor and electrical characteristics indicated. Built-in thermal-overload protection and grease lubricated ball bearings shall be included. Motors are non-overloading within full range of pump performance curves.

2 Apply manufacturer's finish paint to factory-assembled and-tested pump sets prior to shipping. The Engineer shall approve paint color.

3 Manufacturer's Preparation for Shipping: Clean flanges and exposed-machined metal surfaces and treat with anticorrosion compound after assembly and testing. The Contractor shall protect flanges, pipe openings and nozzles with wooden flange covers or with screwed in plugs.
22.2.3 Domestic Water Booster Set

1. Two pump sets; each of them is Skid Mounted, Variable Speed Packaged Booster System, Fully automatic package designed for a total system capacity as specified on different sites equipment’s schedules drawings. Each set is Two pumps in operation and one stand-by, intermittent duty booster set complete with copper pipe work, isolating, check and regulating valves, sustaining pressure valves, pressure gauges, pressure switches, and control panel, prewired and assembled on common base frame. The Contractor shall arrange the set so as each pump rated for 50% of total peak flow rate, two pumps in operation and one pump stand by, with all accessories, control and safety devices shall be provided to give the required performance.

2. Another pump set; located on roof of main bldg. that serve potable water to some main bldg. spcaes. The system is Skid Mounted, Variable Speed Packaged Booster System, Fully automatic package designed for a total system capacity as specified on different sites equipment’s schedules drawings. The set is one pump in operation and one stand-by, intermittent duty booster set complete with copper pipe work, isolating, check and regulating valves, sustaining pressure valves, pressure gauges, pressure switches, and control panel, prewired and assembled on common base frame. The Contractor shall arrange the set so as each pump rated for 100% of total peak flow rate, one pumps in operation and one pump stand by, with all accessories, control and safety devices shall be provided to give the required performance.


4. Casings: Stainless steel or Cast Iron with PN16 flanges for working pressures to 16 bar (232 psig) at 120°C (250°F).

5. Impeller: Stainless Steel, fully enclosed type.


7. Seals: Self-adjusting mechanical seal, with carbon/ceramic seats.

8. Motors: TEFV, 380/3/50V, high efficiency motor and IP55 enclosure variable speed drive, which shall be integrated with the motor.

9. Controller: The control panel shall be of the programmable logic controller (PLC) type. The complete control panel assembly and all internal devices shall be CE marked. The panel shall be complete with IP54 enclosure and include door interlocked main disconnect, water tight LCD interface, breaker VFD connections, adjustable time delays and Hand-Off-Auto selector for each pump. The control circuit shall include fault relay circuit to turn on the next pump should the lead pump fail. The controller must be capable of controlling up to 5 pumps, using a 4-20 mA analogue signal using pressure as the control variable. Controller design shall include provisions for system 'soft fill' mode, low flow energy savings, best-operating-point (BOP) sequencing, automatic alternation of pumps, automatic omission of failed pumps, built-in pump on-delay timers, pump elapsed run time meters, smooth pump starting and sequencing, on-screen field modifiable control and alarm parameters, high system pressure shutdown and no-flow shutdown with draw down tank/system optimization. On-screen alarm display with alarm
identification shall be incorporated with the following alarms included: low and high system pressure alarms, low water shutdown, pump failure, drive fault and discharge pressure transmitter failures. The controller shall include on-screen fault descriptions. Non-volatile factory set parameters must be capable of being restored at any time in the field without requiring any programming device or connection to an external source. The controller must hold software in FLASH memory storage which prevents accidental loss of data due to voltage surge or spike. All controls to be factory pre-wired and tested in accordance with provisions of the national electrical code. All control wires shall be individually numbered and each component shall be labeled accordingly.

10 Integrated Variable Frequency Drive (VFD):
   (a) VFD shall be of the VVC-PWM type providing near unity displacement power factor (cos Ø) without the need for external power factor correction capacitors at all loads and speeds.

11 Instrumentation and Controls Pump system shall be supplied with manifold mounted liquid filled pressure gauges for indicating discharge pressure.

12 Base Frame: Painted welded fabricated mild steel sections suitable for the attachments of vibration isolation, relief valve, sight gauge, pressure switches and drain valves.

22.3 EXECUTION

22.3.1 Examination

1 Examine area equipment, foundations and conditions for compliance with requirements for installation and other conditions affecting performance of pumps. The installation shall not proceed until unsatisfactory conditions have been corrected.

2 Examine roughing-in of piping systems to verify actual locations of piping connections prior to pumps installation.

22.3.2 Equipment Bases

1 Construct concrete equipment pads as follows:
   (a) Concrete pads are to be formed by using lumber with form release compounds, top edge and corners of pad are to be chamfered
   (b) Reinforcing bars are to be installed tied to frame and anchor bolts and sleeves are to be placed using manufacturer's installation template
   (c) Concrete is to be placed and allowed to cure before installation of pumps. Portland cement will be used conforming to ES 373, 300 kPa compressive strength after 28 days and normal weight aggregate

22.3.3 Installation

1 Comply with the manufacturer's written installation and alignment instruction. Pump set shall be installed in location indicated and arranged to provide access for periodic maintenance including removal of motors, impellers, couplings, and
accessories.

2 Pump set and piping shall be supported separately so that the weight of the piping system does not rest on the pump.

3 Pump set shall be set on rectangular metal blocks and shims or on metal wedges having a small taper at points near foundation bolts to provide a gap of 20 mm to 40 mm between pump base and foundation for grouting. Metal supports or wedges shall be adjusted until shafts of pumps and drivers are level. The coupling faces and suction and discharge flanges of each pump shall be checked to verify that they are level and plumb.

4 Plumb pump and motor shafts and align piping connections after setting on foundations, after grout has been set and foundation bolts have been tightened and after piping connections have made.

22.3.4 Connections

1 Install valves that are same size as the piping connected to the pump. Suction and discharge pipe sizes shall be installed equal to or greater than the diameters of the pump nozzles.

2 Non-slam check valve and globe valve shall be installed on the discharge side of each pump. Gate valve and strainer shall be installed on the suction side of each pump.

3 Flexible connectors shall be installed on the suction and discharge side of each pump. Flexible connectors shall be located between the pump casings and discharge valves and upstream the pump suction connection.

4 The Contractor shall install pressure gauge connector plugs in suction and discharge piping at each pump with petcock.

5 The Contractor shall install electrical wiring and make connections to the pump controllers and there from to the motors including control wiring and connections. Electrical power and control wiring and connections are specified in Division 16 Sections.

22.3.5 Field Quality Control

1 Suction line connections shall be checked for tightness to avoid drawing air into pumps. Strainers on pump suction piping should be cleaned. Pump controls shall be set for automatic start, stop and cut out operations as required for system applications.

22.3.6 Commissioning

1 The following preventative maintenance operations and checks shall be performed before start-up:

(a) Lubrication of oil-lubricated bearings;

(b) Removal of grease-lubricated bearing covers and flushing the bearings with kerosene and thoroughly clean. The Contractor shall fill with new lubricant
in accordance with the manufacturer's recommendations;

(c) Disconnection of coupling and checking motor for proper rotation. Rotation shall match direction of rotation marked on pump casing;

(d) Checking that pump is free to rotate by hand. If the pump is bound or even drags slightly, the pump shall not be operated until the cause of the trouble is determined and corrected;

22.3.7 Starting Procedure

1 Starting procedure for pumps with shutoff power not exceeding the safe motor power shall be as follows:

(a) The Contractor shall prime the pump by opening suction valve and closing drains, and prepare the pump for operation

(b) The Contractor shall open the valve in the cooling water supply to the bearings where applicable

(c) Motor shall be started and the discharge valve shall be opened slowly

(d) The Contractor shall check the general mechanical operation of the pumps, motors and the system

2 When pumps to be started against closed check valves with discharge globe valves open, steps are the same except open discharge globe valves some time before motors are started.

22.3.8 Spare Parts

1 Hand over to the Employer the spare parts and tools required for operation and maintenance as recommended by the manufacturer to cover a working period of two years. In addition, submit to the Employer, for approval, a priced list of the above recommended spare parts and tools for an additional period of three years. The list should nominate the above-required items. The approved list shall be part from the operation and maintenance manuals.

22.3.9 Data Sheet

1 For Each Site of the five sites domestic pumps equipment data sheet details and exact locations; kindly refer to both different sites drawings and the equipment's schedule on the following drawings:

(a) Al Shamal Site : Dwg. No. P-51-601.
23. SOLAR WATER HEATERS

23.1 GENERAL

23.1.1 Related Documents

1 Drawings and general provisions of Contract, including General Conditions apply to work of this section.

23.1.2 Summary

1 Extent of water heaters work required by this section is indicated on drawings schedules, and requirements of this section.

23.1.3 Related Sections

1 Part 2 "Basic Mechanical Materials and Methods".
2 All parts for Insulation, Piping, Valves, and Specialties, required in conjunction with electrical Water Heaters.
3 Sections for Electrical Wires/Cables, Raceways, Earthing, and other required electrical devices; not specified in this section.

23.1.4 Quality Assurance

1 Manufacturer's Qualifications: Equipment suppliers must be engaged in the manufacture of solar water heaters of the required type, materials and sizes, whose products have been satisfactorily used in similar service for not less than 10 years.

23.1.5 Standards

1 Comply with the following requirements:
   (a) ASHRAE 90003: Active Solar Heating Design Manual
   (b) ASHRAE 90336: Guidance For Preparing Active Solar Heating Systems - Operation and Maintenance Manuals
   (c) ASHRAE 90342: Active Solar Heating Systems Installation Manual
   (d) ASHRAE 93: Methods of Testing to Determine the Thermal Performance of Solar Collectors
   (e) NFPA 70: National Electrical Code

23.1.6 Submittals

1 Submit each item in the article according to Conditions of the Contract and Division-1 Specification Sections.
2 Product Data: Manufacturer's technical product data for solar water heaters including performance data, materials, dimensions, finish and coatings, insulation, controls, weights; installation requirements, and method of statement
of assembly for components; piping and wiring diagrams.

3 Shop Drawings: Provide drawings for each system type and size containing a system schematic diagram; a collector layout and roof plan noting reverse-return piping for the collector array; a system elevation; a schedule of operation and installation instructions; and a schedule of design information including collector length and width, recommended collector flow rate and pressure drop at that flow rate, number of collectors, number of collectors to be grouped per bank, gross area and net aperture area of collectors, collector fluid volume, collector filled weight, weight of support structure, and tilt angle of collectors from horizontal. Include in the drawings, complete wiring and schematic diagrams, proposed pipe pitch and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work, including clearances for maintenance and operation. Provide a detail of the joint connection between the solar collector mounting brackets and the roof membrane.

4 Solar System Data: Submit calculations of solar system performance leading to the proposed design. Submit reports resulting from the use of any design or performance simulation software used in the design.

5 Wiring Diagrams: Manufacturer’s electrical requirements for electrical power supply wiring to water heaters ladder-type wiring diagrams, including control wiring and interlock required for final installation.

6 Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

7 Field Quality Control: Installation reports.

8 Maintenance Data: Maintenance data and spare parts lists for the water heaters include data in the operation and maintenance manual (O&M).

9 Certificates: Appropriate certificates of shop inspection and data reports signed by manufacturers certifying that the products are in compliance with specified requirements.

23.1.7 Delivery, Storage and Handling

1 Handle solar water heaters and components carefully to avoid damage, breaking, denting and scoring. Never to install damaged units or components; replace with new ones.

2 Store solar water heaters in a clean dry place. Protect from weather, dirt, fumes, humidity, water, construction debris and physical damage.

3 Comply with manufacturer’s rigging and installation instructions for unloading water heaters and moving them to final location.

23.1.8 Warranty

1 Submit written warranty, signed by manufacturer, emphasizing his agreement to replace/repair, within warranty period, solar water heaters, and accessories that
fail as materials or workmanship, including leakage, breakage, improper factory assembled, or failure to perform as required due to production errors. This warranty is in addition to, and not limited to, other rights of the Employer towards the Contractor under Contractual Obligations.

2 The contractor is held responsible for other defects resulting from mishandling, and malfunctions of wrong installation and poor workmanship. Provide labour and bear other costs required for removal and reinstallation of defected materials whether supplied by manufacturer or otherwise.

3 Warranty Period: 3 years from Date of Substantial Completion.

23.2 PRODUCTS

23.2.1 Solar Water Heaters

1 General:

(a) Provide solar water heating (SHW) for closed loop systems with heat-exchanger consists of:

(i) Solar Collector (SC1): Flat plate collector that works according to the forced flow theory. Frame made of anodized aluminum profile, Aluminum back plat, Absorber copper pipes, Glass wool insulation, EPDM [(ethylene propylene diene Monomer (M-class) rubber)] rubber seals for improving the efficiency.

(ii) Storage Tank: Different capacities (refer to drawings), horizontally positioned to allow the most efficient heating cycle by natural flow, Internal tank made of Stainless steel (Glass Enamed steel is approved also), External tank casing made of galvanized steel with electrostatic coating, high density polyurethane thermal insulation, Supplementary heater resistance ranged from 6 to 18 Kw / 240 rated voltage (refer to drawings for each solar water heater capacity) made of copper, with magnesium rod for cathodic protection.

(iii) Heat Transfer Fluid: Heat transfer fluid shall be compatible with all materials in the system. The nature and amount of heat transfer fluid will depend on the type of system proposed and the freeze conditions encountered at the site. Any anti-freeze, conditioners or corrosion inhibitors added to the heat transfer fluid must be non-toxic and intended for use in potable water systems.

(iv) Pumps (for hot water circulation) SHP-(Bldg. Type)-RF-01: Provide electrically-driven, single-stage, centrifugal type circulating pumps. With adequate flow rates and pressure head (refer to drawing for each solar water heater circulation pump spec.). Support pumps on a concrete foundation or mounting intended for the purpose, or by the piping on which installed if appropriate to the size. Construct the pump shaft of corrosion resistant alloy steel with a mechanical seal. Provide stainless steel impellers and casings of bronze. Control motors with switches that can be activated by either the differential temperature controller or by manual override (Hand-Off-Automatic). Pumps shall be installed with isolation valves so the pump can be serviced without draining the system.
(v) And all other related accessories need for the system to functioning with high efficiency (that include but not limited to emergency cooler; in-line vessels; control valves; expansion vessels……etc).

(vi) A hydraulic calculation shall be prepared for all system components and submitted for engineer review and approval.

(vii) Supplied equipment must be rated and warranted to withstand and operate under lowest-record-low and highest-record-high temperature for the location.

23.2.2 Performance Requirements

1 Solar water heating systems must be safe, reliable, require no operator intervention for normal operation, be visually unobtrusive, and be provided in accordance with all applicable codes. Design and size the system so that solar energy supplies approximately the percent of the annualized hot water demand.

23.3 EXECUTION

23.3.1 Installation

1 Flush and disinfect the piping system.

2 Examine areas and conditions under which water heaters shall be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer, and in complete accordance with manufacturer's installation instructions.

23.3.2 Solar Water Heater Connections

1 Provide all components that consist of a solar collector array, array support structure, storage tank, interconnecting piping and fittings, tempering mixing valve, flush-and-fill valves, pressure relief valves, and as required by the system type, any necessary pumps, controls or heat exchangers, as well as all other accessories and equipment required for the proper operation of the solar system.

2 Include with system all labor, supervision, tools, materials and incidentals necessary to installation, checkout and place into operation a complete solar water heating system ready for use for the building.

3 Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

4 Orient controls and devices needing service and maintenance in such a way to have adequate access.

5 Check for the compatibility of materials between pipe work and heaters.

6 Replaced water piping supplying within 3 meters of the SWH system with copper to avoid bulging and rupture due to proximity to the higher temperatures of the solar system.

7 Install temperature and pressure relief valves on top of storage water heater. Use relief valves with sensing elements that extend into tanks.
8 If systems are proposed with multiple collector banks, provide calibrated balancing valves. Furnish calibrated balancing valves with bronze body/brass ball construction with seat rings compatible with system fluid and differential readout ports across valve seat area. Provide readout ports fitted with internal insert of compatible material and check valve. Provide calibrated balancing valves with a memory stop feature to allow valve to be closed for service and reopened to set point without disturbing balance position, and with a calibrated nameplate to assure specific valve settings. Provide calibrated balancing valves and ball valves at the outlet of each collector bank. The balancing valves are specified to allow the array to be flow balanced. The ball valves are required to enable the array to be disconnected for maintenance or repair.

9 Solar collectors are to be mounted on the roof as suitable for the type of SHW system and needs and limitation of the building and site. System must be of a type suitable to the climate of the site.

10 Fit a short length of pipe to relieve valve discharge and extend it to discharge indirectly to the nearest floor drain.

11 Install vacuum relief valves and water heater drain piping. Install hose-end drain valves at low points in water piping for water heater which do not have tank drains.

12 Install temperature indicators and pressure gauges.

13 Install piping adjacent to water heaters to allow service and maintenance.

14 Connect hot-and cold-water piping to units with shut-off valves and unions. Install check valve on cold water pipe.

15 Connect power wiring to units and disconnect switches, ground equipment and tighten electrical connectors and terminals.

16 Provide pump electric motor-driven equipment complete with motor, motor starters, and controls. Provide electrical equipment and wiring in accordance with NFPA 70. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified. Provide each motor of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor.

23.3.3 Collector Subsystem

1 Install solar collector array at the proper tilt angle, orientation, and elevation above roof. Install the solar collectors with the ability to be removed for maintenance, repair, or replacement.

2 Install air vents in the high points of the collector array piping. Provide proper pitch for draining of collector array.

3 Install array support in accordance with the recommendations of the collector manufacturer.

4 Install ball valves at the inlet and outlet of each bank of manifolded collectors. Install calibrated balancing valves at the outlet of each collector bank and mark
final settings on each valve. Install a union adjacent to each ball valve.

23.3.4 Commissioning

1. Provide instructions for each system type. Include in these instructions a system schematic, and wiring and control diagrams showing the complete layout of the solar system. Prepare condensed operating instructions explaining preventative maintenance procedures, balanced flow rates, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, in typed form, framed as specified above, and posted beside the diagrams. Post the framed instructions before acceptance testing of each system.

2. Maintain a written record of the results of all acceptance tests, to be submitted in booklet form. Provide the following tests:

3. Hydrostatically test each system. Isolate valving and instrumentation not suitable for the intended test pressure.

4. Operationally test each system over a period of 48 consecutive hours with sufficient solar insolation to cause activation of the solar energy system during daylight hours.

5. Overall System Operations: Demonstrate each solar energy system will operate properly while unattended for a period of at least 72 hours. As required by system design, demonstrate the system controller will start the pumps after being warmed by the sun, and that it will properly shut down during cloudy weather or in the evening over a minimum of three complete cycles. It is permissible to manipulate the temperature of the storage tank by the introduction of cold water.

23.3.5 Field Training

1. Provide a field training course for operating and maintenance staff members after the system is functionally complete. Include in the training a discussion of the system design and layout and demonstrate routine operation, maintenance and troubleshooting procedures.
24. ELECTRICAL WATER HEATERS

24.1 GENERAL

24.1.1 Related Documents

1 Drawings and general provisions of Contract, including General Conditions apply to work of this section.

24.1.2 Summary

1 Extent of water heaters work required by this section is indicated on drawings schedules, and requirements of this section.

2 Hook-up electrical power supply cables to each electrical water heater.

24.1.3 Related Sections & Works

1 Section 19 part "Basic Mechanical Materials and Methods"

2 Electrical sections of Electrical Wires/Cables, Raceways, Earthing, and other required electrical devices.

24.1.4 Quality Assurance

1 Manufacturer's Qualifications: Equipment suppliers must be engaged in the manufacture of electrical water heaters of the required type, materials and sizes, whose products have been satisfactorily used in similar service and used in the gulf countries for not less than 10 years.

24.1.5 Standards

1 Comply with the requirements of the Qatar Construction specification rules and regulations guide for plumbing and drainage works

24.1.6 Submittals

1 Submit each item in the article according to Conditions of the Contract and all other Specification Sections.

2 Product Data: Manufacturer's technical product data for electrical water heaters including performance data, materials, dimensions, finish and coatings, insulation, controls, weights; installation requirements, and method of statement of assembly for components; piping and wiring diagrams.

3 Shop Drawings: Showing layout of each unit, including tanks, controls, insulation related accessories and piping, wiring.

4 Wiring Diagrams: Manufacturer's electrical requirements for electrical power supply wiring to water heaters ladder-type wiring diagrams, including control wiring and interlock required for final installation.

5 Differentiate between portions of wiring that are factory installed and portions that
are to be field installed.

6 Field Quality Control: Installation reports.

7 Maintenance Data: Maintenance data and spare parts lists for the water heaters include data in the operation and maintenance manual (O&M).

8 Certificates: Appropriate certificates of shop inspection and data reports signed by manufacturers certifying that the products are in compliance with specified requirements.

24.1.7 Delivery, Storage and Handling

1 Handle electrical water heaters and components carefully to avoid damage, breaking, denting and scoring. Never to install damaged units or components; replace with new ones.

2 Store electrical water heaters in a clean dry place. Protect from weather, dirt, fumes, humidity, water, construction debris and physical damage.

3 Comply with manufacturer's rigging and installation instructions for unloading water heaters and moving them to final location.

24.1.8 Warranty

1 Submit written warranty, signed by manufacturer, emphasizing his agreement to replace/repair, within warranty period, electrical water heaters, and accessories that fail as materials or workmanship, including leakage, breakage, improper factory assembled, or failure to perform as required due to production errors. This warranty is in addition to, and not limited to, other rights of the Employer towards the Contractor under Contractual Obligations.

2 The contractor is held responsible for other defects resulting from mishandling, and malfunctions of wrong installation and poor workmanship. Provide labour and bear other costs required for removal and reinstallation of defected materials whether supplied by manufacturer or otherwise.

3 Warranty Period: 5 years from Date of Substantial Completion.

24.2 PRODUCTS

24.2.1 Electrical Water Heaters

1 General: Provide commercial electrical hot water heaters, enameled tank with heater elements, controls and accessories. Electrical water heaters shall be designed and manufactured to meet the requirements of the BS 3456 standard and other related standards for energy conservation. Other approved equal standards may be considered subject to the Engineer's approval.

2 Storage Electric Water Heater (Type EWH): Horizontal, pressure type Glass Lined (300 micron) tank with 1035 kPa working pressure rating and hydrostatically tested to 300 psig at the factory and shall be certified by UL, for water storage up to 85°C, with proper connections for liquid inlets and outlets, combined pressure and temperature relief valve; anti-vacuum valve, air vent
valve, dial type temperature indicator, pressure gauge, thermostats, drain, and magnesium anode rods.

3 Factory apply a minimum of 50 mm thick high quality polyurethane insulation protected with heavy gauge outer steel jacket that bonderizes undercoat and baked enamel finish.

4 Equip the heaters with heavy-duty medium watt density immersion heating elements with sheath and prewired leads, designed to allow for withdrawal of elements from sheaths without draining the vessel, close differential immersion type thermostat, high temperature cut-off switch, and heavy duty magnetic contactors.

5 Control compartment shall house factory prewired 240 V control circuit, branch circuit fuses, heater contactors, control fuse, control starters, and coils. Provide indication power on.

24.3 EXECUTION

24.3.1 Installation

1 Examine areas and conditions under which water heaters shall be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer, and in complete accordance with manufacturer's installation instructions.

24.3.2 Electrical Water Heater Connections

1 Keep heaters upright while transporting or lifting, do not use chains. Install units plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

2 Orient controls and devices needing service and maintenance in such a way to have adequate access.

3 Check for the compatibility of materials between pipe work and heaters. Avoid combination of copper and galvanized steel.

4 Ensure that pipe work ends are square with those on heaters. Allow for pipe expansion by suitable bends or flexible joints. Seal screwed connections with PTFE tape for tapered thread or with a back nut and joint ring for parallel threads.

5 Install temperature and pressure relief valves on top of storage water heater. Use relief valves with sensing elements that extend into tanks.

6 Fit a short length of pipe to relieve valve discharge and extend it to discharge indirectly to the nearest floor drain.

7 Install vacuum relief valves and water heater drain piping. Install hose-end drain valves at low points in water piping for water heater which do not have tank drains.

8 Install temperature indicators and pressure gauges.
9 Install piping adjacent to water heaters to allow service and maintenance.

10 Connect hot-and cold-water piping to units with shut-off valves and unions. Install check valve on cold water pipe.

11 Connect power wiring to units and disconnect switches, ground equipment and tighten electrical connectors and terminals.

24.3.3 Commissioning

1 Before filling the heater with water, check that drain valves are closed and air vents are open. Do not fill quickly to avoid air pocket trap. Close any manual air vents. Crack the vents to release accumulated air.

2 Ensure that anti-vacuum valve is installed in operating condition.

3 Before connecting the heaters to the electric mains, carry out an insulation test across each heating element to earth. If the insulation resistance is less than 500 000 ohms, dry the heater by passing a low voltage element in air. This voltage should not exceed 25% of the working voltage. Do not allow heater elements sheath temperature to rise above 50°C. Switch off at intervals if necessary to prevent overheating.

4 Before putting the heater into service check that the control circuit and main circuit connections are tight using an appropriate size spanner or screwdriver. After connecting the mains ensure that the isolator protective cover is fitted in the correct position. Remove cable ends and other extra-neous matter from the bottom of the compartment, together with any spare items that may be fastened to the cable. Ensure that the fuses are well seated.

5 Test the control system with the mains alive and the main isolator in the "ON" position but with the mains wires to the heater removed. Follow the following for testing:

(a) Switch on the main isolator and with the thermostats connected and the system cold the Contactor should close and unit working light come on. Remove one wire from the control thermostat and the contactor should open switching off the indicator light. Replace wire to the control thermostat and repeat with the safety thermostat, if fitted.

6 During the period that the control thermostat is disconnected, and the contactor open, operate the last button and the contactor should close and the unit working light comes on.

(a) Ensure that heater is full of water.

(b) Reconnect heater. Check the water connections for tightness.

7 When replacing the immersion heater lid ensure that this does not trap any wires or cause them to press against thermostat adjuster. Check that this switches off as water heats up by adjusting thermostat setting.

8 Ensure that thermostats are set to the correct temperature point and as far in the pocket as possible.
9 Important Precautions

(a) Take all precautions against electric shock by switching off between tests and ensuring that loose wires are not in contact with any metal work or in dangerous positions.

(b) Make sure the floor is dry before handling electrical equipment.

10 Check the recovery time for heating the water contents from cold with the return valve isolated and with no draw off. Ensure that the performance is in compliance with the system requirements. Similarly, during the same recovery period, check the temperature and flow conditions of the primary calibrate controls of the heaters and adjust working conditions for maximum efficiency.

11 Electric Water Heater

(a) The Capacities and Electric Load were indicated on the drawings.
25. VARIABLE SPEED IRRIGATION PUMP SETS

25.1 GENERAL

25.1.1 Related Documents

1 Drawings and general provisions of the Contract, including the General conditions, Conditions of Particular Applications and Specification Sections, apply to this Section.

25.1.2 Description of Work

1 This Section includes the irrigation water pumps.

25.1.3 Related Sections

1 The following sections contain requirements that relate to this section:

   (a) Section 19 for piping not specified in this Section

25.1.4 Pump Performance Requirements

1 Pump Pressure Ratings: At least equal to system maximum operating pressure at point where installed, but not less than 850 kPa.

2 NPSH: Self priming pumps shall be supplied wherever required and for the above grade installation unless the NPSH required for the pump is equal or less than the NPSH available at each particular case.

25.1.5 Submittals

1 Submit the following according to the Conditions of the contract and Specification Sections.

2 Product data: including certified performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories. Include startup instructions.

3 Shop drawings: showing layout and connections for pumps. Include setting drawings with templates, recommendations for installation, foundation and anchor bolts, and other anchorages.

4 Wiring diagrams: detailing wiring for power, signal, and control systems differentiating between manufacturer-installed wiring and field-installed wiring.

5 Product certificates: signed by pump manufacturers certifying accuracies under specified operating conditions and compliance with specified requirements.

6 Maintenance data: for each type and pump size specified to include in the "Operation and Maintenance Manual" as specified in Section "Project Closeout".
25.1.6 Quality Assurance

1. Comply with provisions of the following:
   (a) ASME B31.9 "Building Services Piping" for piping materials and installation.
   (b) H.I.S "Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps" for pump design, manufacture, and installation.
   (c) NEMA MG 1 "Standard for Motors and Generators" for electric motors.
   (d) NFPA 70 "National Electrical Code" for electrical components and installation.

2. Single-Source Responsibility: Obtain same type of pumps from a single manufacturer with pumps, motors, control panels, components, and accessories from a single source. Include responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

3. Design Criteria: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Engineer. The burden of proof for equality of pumps is on the proposer.

25.1.7 Delivery, Storage, and Handling

1. Store pumps in a clean, dry location. Retain shipping flange protective covers and protective coatings during storage. Protect bearings and couplings against damage from sand, grit, or other foreign matter.

2. For extended storage greater than 5 days, dry internal parts with hot air or a vacuum-producing device. After drying, coat internal parts with light oil, kerosene, or antifreeze. Dismantle bearings and couplings, dry and coat with acid free heavy oil, and tag and store in a dry location.

3. Comply with pump manufacturer's rigging instructions for handling.

25.2 PRODUCTS

25.2.1 Manufactures

1. Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal.

25.2.2 Pumps, General

1. Factory assembled and tested pumps of construction required for permanent installation with single NEMA MG 1 speed with type of enclosure and electrical characteristics indicated. Include built-in thermal-overload protection and grease lubricated ball bearings. Motors are non overloading within full range of pump performance curves.
2 Apply manufacturer's finish paint to factory-assembled and-tested pump sets prior to shipping. Paint color shall be approved by the Engineer.

3 Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings and nozzles with wooden flange covers or with screwed in plugs.

25.2.3 Irrigation Pumps

1 General Description: Variable Speed Centrifugal, close-coupled, end-suction, single-stage, bronze trimmed design, rated for 400 kPa working pressure. Include back-pull-out design. The irrigation pump sets are:

(a) In Al Shamal Site; two pumps each pump is rated for full load, one pump in operation and the other pump stand by

2 Casings: cast iron with flanged piping connections, and threaded gage tapings at inlet and outlet flange connections.

3 Impeller: ASTM B 584 cast bronze impeller statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft, and secured by a locking cap screw, replaceable bronze casing wearing ring, stainless steel shaft with bronze sleeve. Include flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.

4 Mechanical Seals: Carbon-steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.

5 Motor: TEFC, squirrel – cage, Class F insulation with temperature rise limited to class B, the stator winding shall be made of copper.

6 Pump Specialties: Include the pump specialties with end connections matching pump and piping where indicated and/or required for proper operation. Refer to Division 15 Section "Valves" for general-duty gate, ball, butterfly, globe, and check valves.

25.2.4 Control Panels

1 Dust-and waterproof painted steel enclosure with, but not limited to, the following:

(a) The control panel shall be of the programmable logic controller (PLC) type. The complete control panel assembly and all internal devices shall be at least CE marked. The panel shall be complete with IP54 enclosure and include door interlocked main disconnect, water tight LCD interface, breaker VFD connections, adjustable time delays and Hand-Off-Auto selector for each pump. The control circuit shall include fault relay circuit to turn on the next pump should the lead pump fail. The controller must be capable of controlling up to 5 pumps, using a 4-20 mA analogue signal using pressure as the control variable. Controller design shall include provisions for system 'soft fill' mode, low flow energy savings, best-operating-point (BOP) sequencing, automatic alternation of pumps, automatic omission of failed pumps, built-in pump on-delay timers, pump
elapsed run time meters, smooth pump starting and sequencing, on-screen field modifiable control and alarm parameters, high system pressure shutdown and no-flow shutdown with draw down tank/system optimization. On-screen alarm display with alarm identification shall be incorporated with the following alarms included: low and high system pressure alarms, low water shutdown, pump failure, drive fault and discharge pressure transmitter failures. The controller shall include on-screen fault descriptions. Non-volatile factory set parameters must be capable of being restored at any time in the field without requiring any programming device or connection to an external source. The controller must hold software in FLASH memory storage which prevents accidental loss of data due to voltage surge or spike. All controls to be factory pre-wired and tested in accordance with provisions of the national electrical code. All control wires shall be individually numbered and each component shall be labeled accordingly.

2 Integrated Variable Frequency Drive (VFD):
   (a) VFD shall be of the VVC-PWM type providing near unity displacement power factor (cos $\Phi$) without the need for external power factor correction capacitors at all loads and speeds.

3 Instrumentation and Controls Pump system shall be supplied with manifold mounted liquid filled pressure gauges for indicating discharge pressure.

4 Base Frame: Painted welded fabricated mild steel sections suitable for the attachments of vibration isolation, relief valve, sight gauge, pressure switches and drain valves.

25.3 EXECUTION

25.3.1 Examination

1 Examine areas, equipment foundations, and conditions for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections prior to pump installation.

25.3.2 Installation

1 Install pumps according to the manufacturer's written installation instructions. Install pumps in locations indicated and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories. Support pumps and piping so that weight of piping is not supported by pumps.

2 Install Vertical Multi-Stage pumps on concrete bases.

3 Comply, where applicable, with the requirements of Specification Section 19 part 16 Domestic & Treated water booster pump set.

25.3.3 Connections

1 Connect piping to pumps as indicated. Install valves that are same size as piping
connecting to pumps. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

2 Install shutoff valve and strainer on suction side and check valve and globe valve on discharge side. Install flexible pipe connectors on suction and discharge of pumps. Install flexible pipe connectors on upstream from pump suction diffusers and strainers, and between pump casings and discharge valves. Install pressure gages on suction and discharge of each pump at integral pressure gage tapings.

3 Install electrical wiring and make connections for power, controls, and devices. Electrical power and control wiring and connections are specified in Electrical Specs Sections.

25.3.4 Field Quality Control

1 Check suction piping connections for tightness to avoid drawing air into pumps. Clean strainers on pump suction piping. Set pump controls for automatic start, stop, and alarm operation.

25.3.5 Commissioning

1 Perform the following preventive maintenance operations and checks before startup:

(a) Lubricate oil-lubricated-type bearing. Remove grease-lubricated bearing covers and flush bearings with kerosene and thoroughly clean. Fill with new lubricant according to manufacturer’s recommendations. Disconnect couplings and check motors for proper rotation. Rotation shall match direction of rotation marked on pump casing. Check that pumps are free to rotate by hand.

(b) Do not operate pump if bound or if it drags even slightly until cause of trouble is determined and corrected. Check that pump controls are correct for required application.

25.3.6 Starting Procedure

1 Starting procedure for pumps with shutoff power not exceeding safe motor power shall be as follows:

(a) Prime pumps by opening suction valves and closing drains, and prepare pumps for operation. Open cooling water supply valves if stuffing boxes are water cooled, open circulating line valves if pumps should not be operated against shutoff head.

(b) Start motors, open discharge valves slowly.

(c) Observe leakage from stuffing boxes and adjust sealing liquid valves for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes, then tighten glands.

(d) Check general mechanical operation of pumps and motors. Close circulating piping valves once there is sufficient flow through pump to prevent overheating.
(e) Remove startup strainers from suction diffusers and install permanent strainers after system has been in operation.

(f) When pumps are to be started against closed check valves with discharge globe valves open, steps are same except open discharge globe valves some time before motors are started.

25.3.7 Spare Parts

1 Hand over to the Employer the spare parts and tools required for operation and maintenance as recommended by the manufacturer to cover a working period of two years. In addition, submit to the Employer, for approval a priced list of the above recommended spare parts and tools for an additional period of three years. The list should nominate the above required items. The approved list shall be part from the operation and maintenance manuals.

Note:

1 For each irrigation pump set configuration, refer to irrigation pump/tank equipment room drawings under water supply system.

2 For Each Site the Irrigation pumps equipment data sheet details and exact locations; kindly refer to both different sites water supply drawings and the equipment's schedule on the following drawings:

(a) Al Shamal Site : Dwg. No. P-51-601.
SECTION 20

DRAINAGE WORKS FOR BUILDINGS
8. PLUMBING SPECIALTIES

8.1 GENERAL

8.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General and Supplementary, apply to this Section.

8.1.2 Summary

1 This Section includes plumbing specialties for water distribution systems; soil, waste, vent and storm drainage systems.

2 Related Sections: The following sections contain requirements that relate to this Section:

(a) Section 19 Part 2 "Basic Mechanical Materials and Methods" for piping-jointing materials, joint construction, basic installation requirements, and labeling and identifying requirements.

(b) Section 19 Part 9 "Valves" for gate, ball, butterfly, globe, and check valves.

(c) Section 19 Part 12 "Plumbing Works" for piping and connections.

8.1.3 System Performance Requirements

1 Provide components and installation capable of producing systems conforming to Qatar Regulations and BS & all equivalent Standard.

8.1.4 Submittals

1 General: Submit the following in accordance with Conditions of Contract and all Specification Sections.

2 Submit product data including rated capacities of selected models and weights (shipping, installation, and operation). Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products:

(a) Pressure regulators

(b) Water filters

(c) Strainers

(d) Hose bibbs

(e) Drain valves

(f) Cleanouts, cover plates, and access panels

(g) Vent caps, vent terminals, and roof flashing assemblies
(h) Floor drains, open receptors and trench drains
(i) Sleeve penetration systems
(j) Maintenance data for inclusion in the Operation and Maintenance Manuals as specified in specifications.

8.1.5 Quality Assurance

1 Comply with BS 31.9, “Building Services Piping” for materials, products, and installation.

2 Electrical Components Standard: “National Electrical Code”.

3 Design Concept: The Drawings indicate capacities, sizes, and dimensional requirements of system components. Components having equal performance characteristics, that deviating from the indicated size and dimensions may be accepted provided deviations do not change the design concept or intended performance. The burden of proof for equality of products is on the Contractor.

8.1.6 Extra Materials

1 Deliver Extra Material to Owner: Furnish extra materials matching products installed as described below. Package them with protective covering for storage and identify with labels clearly describing contents.

2 Operating Key (Handles): Furnish 1 extra key for each key operated hose bibb and hydrant installed.

8.2 PRODUCTS

8.2.1 Manufacturers

1 Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal.

8.2.2 Water Pressure Regulators

1 ASSE 1003, water pressure regulators, rated for initial working pressure of 1000 kPa minimum, of size, flow rate, and inlet and outlet pressures indicated or required by system performance. Corrosion-resistant interior components, polished chrome plate exterior finishing in chrome plated piping system. Include integral factory-installed or separated field-installed Y-type strainer.

2 50 mm and Smaller: Bronze body with threaded ends.

3 65 mm and Larger: Cast-iron body with flanged ends with FDA approved epoxy interior lining.
8.2.3 Backflow Preventors

1 ASSE standard, backflow preventers, corrosion resistant internal components with inlet strainer, 850 kPa minimum working pressure except where indicated otherwise.

2 50 mm and Smaller: Bronze body with threaded ends.

3 65 mm and Larger: Cast-iron body with flanged ends with FDA approved epoxy interior lining.

4 Hose Connection Vacuum Breakers: ASSE 1001, nickelplated, with nonremovable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

8.2.4 Miscellaneous Piping Specialties

1 Piping Specialties such as escutcheons, dielectric fittings, sleeves, and sleeve seals are specified in Section 19.

2 Hose Bibbs: 20 mm chrome plated bronze body, with renewable composition disc, 20 mm threaded joint inlet. Provide ASME B1.20.7 garden-hose threads on outlet and integral hose-connection vacuum breaker. Indoor bibbs to be provided with handles while outdoors to be operated by key. Provide 1 operating key for every 5 hose bibbs as Fig. No. S8C/8A - C.

3 Hose-End Drain Valves: 20 mm ball valve, rated for 2700 kPa WOG. Include 2-piece bronze body conforming to ASME B62, standard port, chrome-plated brass ball, replaceable "TFE" seats and seals blowout-proof stem, and vinyl-covered steel handle.

4 Vent Caps: Standard manufacturers' product, cast-iron body with threaded or sub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.

5 Water Hammer Arrestors: ASME A112.26.1M, ASSE 1010, or PDI WH-201, bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units, ASME A112.26.1M, sizes "A" through "F" and PDI WH-201 sizes "A" through "F".

6 Vent Terminal: Commercially manufactured assembly constructed of copper. Size to provide 25 mm enclosed air space between outside of pipe and inside of flashing collar extension, with counter flashing.

7 Roof Flashing Assemblies: Manufactured assembly consisting of 1.6 mm lead flashing collar with boot and skirt extending at least 200 mm from pipe, with galvanized steel boot reinforcement and counter flashing fitting.

8 Extended model with field-installed, vandal-proof vent cap.
8.2.5 Cleanouts

1 General: Size cleanouts as indicated on drawings, or where not indicated, same size as connected drainage piping.

2 Cleanouts: ASME A112.36.2M, cast-iron body with straight threads and gasket seal or taper threads for plug, flashing flange clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring. See Product Data Sheets at end of Part 3 of this Section for deck plate shape, top-loading classification, access cover, finish, and other specific features.

8.2.6 Floor Drains

1 General: Size outlets as indicated on drawings.

2 Cast Iron Floor Drains: Cast iron body and nickel bronze grate and cover With seepage flange and clamping device. Floor drains for installation in floors not having membrane waterproofing may have seepage flange without clamping device. Floor drains for use as area drains in exterior slab on grade may be furnished with anchor flange instead of seepage flange and clamping device. Provide funnel for floor drains in the locations of indirect drain to prevent water supply. See Product Data Sheet at the end of Part 3 of this Section for materials, shape, dimensions and body top finish, top-loading classification, and specific features.

3 Plastic Floor Drains: PVC or HDPE body with adjustable stainless steel 100 mm square slotted grate provided with lateral inlets and an outlet with removable pipe cleaning plug. The seal trap shall be 50 mm minimum.

4 The non-metal floor drains shall be installed in toilets & janitors. For detailed feature and shape refer to the product data sheets at end of Part 3 of this section.

5 Provide funnels for floor drains in the locations of indirect waste drain.

6 Sterile Floor Drain: Stainless steel body with cast stainless steel 100 mm square slotted grate and stainless steel double seal cover, double seal trap, constructed of 14/304 stainless steel with seepage flange and clamping device. Floor drains for installation in floors not having membrane waterproofing may have seepage flange without clamping device. Floor drains for use as area drains in exterior slab on grade may be furnished with anchor flange instead of seepage flange and clamping device. Provide funnel for floor drains in the locations of indirect drain to prevent water supply.

7 Air Gap Fittings: ASME A112.1.2, cast iron or cast bronze, with fixed air gap, inlet for drain pipe or tube, and threaded or spigot outlet.

8.2.7 Road Drain Points (RDP):

1 Heavy duty suitable for car and trench loading coated cast iron, 12-inch (300 mm),
8.2.8 Roof Drains

1 General: Size outlet as indicated on drawings.

2 Roof Drains: ASME A112.21.2M, cast iron body, with combination flashing ring cast iron dome except where other dome material is specified, extension collars, underdeck clamp, and sump receiver. Roof drains for installation in cast-in-place concrete decks may be furnished without underdeck clamp and sump receiver. See Product Data Sheet at end of Part 3 of this Section for dimensions, sump size, dome material, and specific features.

8.2.9 Trench Drains

1 ASME A 112.21.1M, cast-iron body, with seepage flange and clamping device. Trench drains for installation in floors not having membrane waterproofing may have seepage flange without clamping devices. Trench drains for use as area drains in exterior slab on grade may be furnished with anchor flange or other anchoring device instead of seepage flange and clamping device. See Product Data Sheet at end of Part 3 of this Section for shape, dimensions, grate material, grate and body top finish, top loading classification, sump size, number of outlets, and specific features.

8.2.10 Trench Grates

1 Ductile iron trench grate and Epoxy coated steel frame with anchor stirps.

8.2.11 Grease Interceptors

1 General: Units of type, operation, flow rate, storage or retention capacity, with integral or field-installed cleanout on outlet; and other features indicated. Locate the fabricated interceptors and traps in concrete pits, externally waterproofed.

2 Grease Interceptors: Acid resistant coated interior and exterior fabricated steel grease interceptor, with internal relief bypass, bronze clean-out plug and visible double wall trap seal with removable pressure equalizing/flow diffusing baffle and sediment tray. Gasketed non-skid secured cover with cover recessed lift handle and enzyme port having bronze plug, complete with flow control fitting, extended section as required by site conditions. See Product Data Sheet at end of Part 3 of this section flow rate and grease capacity.

3 Final capacity and dimensions to be coordinated with kitchen equipments supplier/calculated then submitted for review/approval.

8.2.12 Oil Interceptor

1 Type: recessed type, flush with floor.
2 Components: body and cover, removable sediment bucket, baffles, adjustable gravity oil draw-off, vent connections, flow control fittings on inlet and air relief bypass.

3 Body: to be acid resistant coated interior, and exterior fabricated steel.

4 Cover: to be gasketed, non-skid, secured type.

8.2.13 Sleeve Penetration Systems

1 Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with fire stopping plug.

8.2.14 Flashing Materials

1 Lead: ASTM B 749, Type L51121, copper-bearing sheet, at least 1.6 mm thick for general use, and at least 2.5 mm for burning (welding), except as otherwise indicated.

8.2.15 Waste Oil Storage Tank

1 Acid resistant coated interior and exterior fabricated, steel tank with vent pipe, draw off point extend to grade and inlet connection, capacity and dimensions to be coordinated/calculated then submitted for review/approval.

8.2.16 Water Hammer Arrestors

1 ASME A112.26.1M, ASSE 1010, or PDI WH-201, bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units, ASME A112.26.1M, sizes "A" through "F" and PDI WH-201 sizes "A" through "F".

8.2.17 Micro - Filter

1 GENERAL: unit to be suitable for the quality of water at the Project.

2 MICRO – FILTER: to consist of micro filters piped together, ensuring at the outlet of the unit, potable water free from any sediment.

3 MICRO – FILTER: to be of welded 304 stainless steel construction with all stainless steel internal parts and provided with gate valves on both inlet and outlet. Filter media to be of the replaceable cartridge type capable of removing particles down to 5 microns.

4 DIFFERENTIAL PRESSURE GAUGE AND SWITCH to be provided for pressure drop monitoring.

8.2.18 Ultra-Violet Sterilizing Unit

1 UNIT: to include 304 stainless steel sterilizing chambers with removable head. UV lamps to slide into high purity sleeves. Sleeves are attached to chamber head so they may be easily removed as a bundle for inspection or cleaning. Flow regulator
on discharge line to maintain flow to ensure an exposure dosage of 30000 micro watt-sec/cm². Sterilizer to include high powered ballast, fuse, power safety switch, all inside white enamel housing with stainless steel cover and electrical cord.

2 UNIT: to include UV intensity sensor and meter with safe/unsafe zones to indicate UV below effective range, mounted on sterilizer housing.

8.2.19 Drinking Water Filters

1 UNIT renewable cartridge, sterilising, pressure type, to fit directly on any water tap feed pipe, minimum rated capacity 50 litres per hour at pressure of 200 kPa and good for working pressure of 800 kPa. Filters to have cast iron housing finished with white enamel internally and externally, chrome plated brass swivelling spout, inlet valve, drain cock and removable cover for easy cartridge removal without need for tools. Cartridge to be special filtering material designed to retain bacteria and impurities and remove objectionable tastes, colours and odours.

8.2.20 Neutralisation Pit

1 Construction: in situ reinforced concrete with opening in top, recessed to accommodate cast iron manhole frame and cover, as shown on the Drawings.

2 Finish: plaster internal walls with two coats cement mortar to thickness of 15 mm. Coat entire internal surface with approved epoxy-polyamide based two-pack waterproof and acid resisting coating.

3 Piping to be polyethylene.

4 Neutralisation Material to be crushed limestone and any other needed neutralization material or approved equal assure 100% Neutralized Drain to ASHGHAL Sewer Network acceptable limits and that satisfy both Physical & Chemical analysis to local and international codes. For analysis Procedures refer to following:

(a) The Contractor shall Take Water samples from the site after the Dilution Pit. Testing for this sample must occur in two phases:-

(b) A physical analysis of water samples should be conducted on-site to ensure accuracy as water samples obtained onsite will exist in equilibrium with the surroundings.

(c) A chemical analysis of water samples collected from the site should be conducted in a qualified laboratory to ensure no toxic substances are present.

(d) Sample water Testing must measure the following factors to detect for water contamination:-

   Physical analysis
   • Potential Hydrogen (pH)
   • Temperature
• Total suspended solids (TSS)
• Turbidity
• Total dissolved solids (TDS)
• Radioactivity

Chemical analysis
• Dissolved oxygen (DO)
• Nitrate-N
• Orthophosphates
• Chemical oxygen demand (COD)
• Biochemical oxygen demand (BOD)
• Pesticides
• Metals

(e) If no toxic or harmful substances are present on the project site after Dilution Pit, Hence the Dilution Pit & its Neutralization Material are approved, otherwise another Dilution Pit with another Neutralization Material to be provided to fulfill with above requirements and Local Authorities/GSAS requirements/Engineer Approval.

(f) Dilution Pit shall have warranty for 10 years, Periodic Maintenance/Cleaning schedules with delivering a Min. 2 Years operation of Neutralization Material amount enough within the Healthcare center Natural operation.

5 Manhole Covers are to fit frames. Replace if found to rattle under traffic. Plugging, burning in or filling to obtain tight covers will not be allowed.

6 Manhole Covers: recess in concrete is to be neatly and accurately made to dimensions of frame. Thoroughly embed frame in mortar and set frame and cover level and to proper grade.

8.2.21 Packaged deionization system

Supply, install, test and commission Packaged deionization system includes but not limited to packaged deionization unit, piping, valves, filters, Micro filters, UV lamp unit, electrical works, control unit, interface and all other accessories needed to work adequately, to be fed with potable water source and produce deionized water supply sufficient to cover the flow/quality requirements (not less than 2gpm) for supplying sterilization equipment(s) located into sterilization room in accordance to client and/or engineers requirements, in according QCS 2010. The packaged deionized water system supplier to coordinate with both main contractor & sub-contractors (medical equipment, plumbing, electrical, BMS ....etc), for space, unit foundation dim., medical equipment required flow rate, water quality and other requirements/interfacing needed for the system adequate operation.
8.3 EXECUTION

8.3.1 Piping Specialty Installation

1. Install pressure-regulating valve with inlet and outlet shut-off valves and balance cock bypass. Install pressure gage on valve inlet and outlet and install valved bypass where indicated.

2. Install strainers on supply side of each control valve, pressure-regulating valve, and solenoid valve, and where indicated.

3. Install hose bibbs and wall hydrants with integral vacuum breaker.

4. Install cleanouts in above ground-piping and building drain piping as indicated, and where not indicated, according to the following:
   
   (a) Size same as drainage piping up to 100 mm. Use 100 mm size for larger drainage piping except where larger size cleanout is indicated.
   
   (b) Locate at each change in direction of piping greater than 45 degrees and at maximum intervals of 15 m for piping 100 mm and smaller and 30 m for larger piping.
   
   (c) Locate at base of each vertical soil or waste stack.
   
   (d) Install cleanout wall access covers with frame and cover flush with finished wall.

5. Install flashing flange and clamping with each stack and cleanout passing through floors having waterproof membrane.

6. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to the manufacturer’s written instructions.

8.3.2 Floor Drain Installation

1. Install floor drains according to manufacturer’s written instructions, in locations indicated.

2. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor. Provide traps for drains.

3. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated. Install drain funnel and priming connections where required.

4. Position drains for easy accessibility and maintenance.
8.3.3 Roof Drain Installation

1. Install roof drains at low points of roof areas, according to the roof membrane manufacturer’s installation instructions.

2. Install drain flashing collar or flange so no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.

3. Position roof drain for an easy accessibility and maintenance. Coordinate with roof levels, expansion joints and equipment located thereon.

8.3.4 Interceptor Installation

1. Comply with unit manufacturer’s written installation instructions and the code requirements for trapping and venting.

2. Provide units clear space for servicing. Install waste piping, flow control fitting, vent piping, and accessories as indicated and or required for proper operation.

3. Coordinate oil storage tank and gravity drain. Set unit and extension when required, with cover flush with finished floor. Set unit in pit and install cleanout immediately downstream of interceptor units not having integral cleanout on outlet.

8.3.5 Connection

1. Supply Runouts to Fixtures: Install hot- and cold-water supply piping runouts to fixtures of sizes indicated, but not smaller than required by plumbing code.

2. Drainage Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated, but not smaller than required by plumbing code.

8.3.6 Flashing Installation

1. Provide flashing manufactured in a single piece except where large sumps, or other drainage shapes are required.

2. Install 1.6 mm lead flashing except when another weight or material is specified. Install 2.5 mm lead flashing or heavier where burning (welding) of lead sheets is required.

3. Pipe Flashing: Sleeve type, matching pipe size, with minimum sleeve length 200 mm and skirt or flange extending at least 200 mm around pipe.

4. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 200 mm around sleeve.

5. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 200 mm around specialty.

6. Set flashing on floors and roofs in solid coating of bituminous cement. Secure
flashing into sleeve and specialty clamping ring or device.

7 Extend flashing up vent pipe passing through roofs and turn down into pipe or secure flashing into cast-iron sleeve having caulking recess.

8 Fabricate and install lead sheet flashing install drain connection when indicated.

8.3.7 Commissioning

1 Preparation: Perform the following Checks before start-up:

2 Systems tests are complete.

3 Before Operating Systems perform these steps:

   (a) Close drain valves, hydrants, and hose bibbs.
   (b) Open valves to full open position.
   (c) Remove and clean strainers.
   (d) Verify drainage and vent piping are clear of obstructions.
   (e) Flush with water until clear.

4 Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturer, start and run units through complete sequence of operations.

8.3.8 Adjusting

1 Adjust operation and correct deficiencies discovered during commissioning.

8.3.9 Protection

1 Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

2 Place plugs in ends of uncompleted piping at end of day or when work stops.

8.3.10 Spare Parts

1 Hand over to the Employer spare parts and tools required for the operation and maintenance of the work for a period of one year.

2 Plumbing Specialties Product Data Sheets

3 Available Products: Subject to compliance with requirements, plumbing specialties that may be incorporated in the work include, but are not limited to, the products specified in each Specialties Product Data Sheet.

4 Abbreviations: Used in the following Data Sheets include:
| AD | AREA DRAIN              |
| B  | BRONZE                  |
| CI | CAST IRON              |
| CG | COMPRESSION GASKET     |
| D  | DOME                    |
| DI | DUCTILE IRON           |
| FCO| FLOOR CLEANOUT         |
| FD | FLOOR DRAIN            |
| GS | GALVANIZED STEEL       |
| HD | HEAVY DUTY             |
| XHD| EXTRA HEAVY DUTY       |
| IG | INSIDE GASKET          |
| LD | LIGHT DUTY             |
| MD | MEDIUM DUTY            |
| NB | NICKEL BRONZE          |
| PD | PLANTER DRAIN          |
| POG| PUSH-ON GASKET         |
| NH | NO-HUB                 |
| R  | ROUND                   |
| S  | SQUARE                  |
| S.ST| STAINLESS STEEL        |
| GCO| GROUND CLEANOUT        |

| 5  | Floor/Ground Cleanout |

<table>
<thead>
<tr>
<th></th>
<th>FCO1</th>
<th>FCO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>CI</td>
<td>CI</td>
</tr>
<tr>
<td>Outlet</td>
<td>POG-Bottom</td>
<td>POG-Bottom</td>
</tr>
<tr>
<td>Cover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>NB</td>
<td>DI</td>
</tr>
<tr>
<td>Shape</td>
<td>S</td>
<td>R</td>
</tr>
<tr>
<td>Size (mm)</td>
<td>180</td>
<td>180/230</td>
</tr>
<tr>
<td>Duty</td>
<td>LD</td>
<td>HD</td>
</tr>
<tr>
<td>Location</td>
<td>Toilets &amp; Janitor</td>
<td>Pump room &amp; Chillers</td>
</tr>
</tbody>
</table>
6 Floor Drains

<table>
<thead>
<tr>
<th></th>
<th>FD1</th>
<th>FD2</th>
<th>FFD3</th>
<th>FD4</th>
<th>TD</th>
<th>RDP</th>
<th>PD</th>
<th>TRD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>PVC</td>
<td>CI</td>
<td>CI</td>
<td>S.St</td>
<td>CI</td>
<td>CI</td>
<td>CI</td>
<td>CI</td>
</tr>
<tr>
<td>Outlet</td>
<td>NH</td>
<td>IG- Bottom</td>
<td>IG- Bottom</td>
<td>IG- Bottom</td>
<td>IG- Bottom</td>
<td>IG- Bottom</td>
<td>IG- Bottom</td>
<td>IG- Bottom</td>
</tr>
<tr>
<td>Grate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Nickel</td>
<td>DI</td>
<td>DI</td>
<td>S.St</td>
<td>DI</td>
<td>DI</td>
<td>DI</td>
<td>NB</td>
</tr>
<tr>
<td>Shape</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>-</td>
<td>Dom e</td>
</tr>
<tr>
<td>Size (mm)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Funnel</td>
<td>Yes</td>
<td>-</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bucket</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Duty</td>
<td>LD</td>
<td>HD</td>
<td>MD</td>
<td>LD</td>
<td>MD</td>
<td>HD</td>
<td>-</td>
<td>LD</td>
</tr>
</tbody>
</table>

Locations

(a) Provide Funnel where required for any indirect waste.

(b) With NB Head, with clamp collar, stainless steel 50 mm dia. perforated stand pipe with reasonable length for plantation layers and dome.

7 Roof Drains

<table>
<thead>
<tr>
<th></th>
<th>RD1</th>
</tr>
</thead>
<tbody>
<tr>
<td>BODY</td>
<td>CI</td>
</tr>
<tr>
<td>DOME</td>
<td>CI-300 mm dia</td>
</tr>
<tr>
<td>OUTLET</td>
<td>POG-Bottom</td>
</tr>
<tr>
<td>GRAEL GUARD</td>
<td>Perforated SS</td>
</tr>
</tbody>
</table>

8 Oil Interceptors

<table>
<thead>
<tr>
<th></th>
<th>GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Rate L/S</td>
<td>Approx. 4.7</td>
</tr>
<tr>
<td>Installation</td>
<td>On Ground Floor</td>
</tr>
</tbody>
</table>
### Location

& BASEMNT Floor  
(Ancillary Bldg. - Generator Room).

9 Trench Grate

<table>
<thead>
<tr>
<th></th>
<th>TRG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>DI</td>
</tr>
<tr>
<td>Grate</td>
<td>DI</td>
</tr>
<tr>
<td>Trench</td>
<td>Concrete</td>
</tr>
<tr>
<td>Duty</td>
<td>HD</td>
</tr>
<tr>
<td>Width</td>
<td>300</td>
</tr>
<tr>
<td>Location</td>
<td>Basement &amp; Site</td>
</tr>
</tbody>
</table>
9 SUMP PUMPS

9.1 GENERAL

9.1.1 Related Documents

1 Drawings and general provision of the Contract, including the General Conditions, and Conditions of Particular Applications apply to this Section.

9.1.2 Description of Work

1 This section includes the following types of pumps for permanent installation in plumbing systems:

2 Sump pump sets

3 The capacity of the pump sets is indicated in the end of this section.

9.1.3 Related Sections & Works

1 The following sections contain requirements that relate to this section:

2 Section "Electrical Requirements for Mechanical Equipment" for pump motors.

3 Sections for piping not specified in this section.

4 (Electrical Specs) sections for power-supply wiring, field-installed disconnects, required electrical devices, and motor controllers.

9.1.4 Definitions

1 Automatic, Packaged Pump Sets: Type suitable for automatically lifting drainage to a point of discharge. Set is complete with pump, motors, controls, valves, and basin.

2 Permanent-Installation Pumps: Type suitable for fixed installation and connection to piping systems.

3 Submersible Pumps: Type that operates with motor submerged in water.

4 Sump Pumps: Type suitable for lifting wastewater from a sump or wet location to a point of discharge. Pumps have strainer on inlet. This type includes submersible sump pumps.

9.1.5 Pump Performance Requirements

1 Pump Pressure Ratings: At least equal to maximum pump-operating pressure.
9.1.6 Submittals

1. Submit the following according to the Conditions of the Contract and all Specification Sections.

2. Product data including certified performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories. Include startup instructions.

3. Shop drawings showing layout and connections for pumps. Include setting drawings with templates, directions for installation of foundation and anchor bolts, and other anchorages.

4. Wiring diagrams detailing wiring for power, signal, and control systems differentiating between manufacturer-installed wiring and field-installed wiring.

5. Product certificates signed by pump manufacturers certifying accuracies under specified operating conditions and compliance with specified requirements.

6. Maintenance data for each type and size pump specified to include in the Operating and Maintenance Manual.

9.1.7 Quality Assurance

1. Comply with provisions of the SAME B31.9 "Building Services Piping" for piping materials and installation, H.I. "Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps" for pump design, manufacture, and installation, moreover the Qatar Construction specification rules and regulations guide for plumbing and drainage works.

2. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labelling and NFPA 70 "National Electrical Code" for electrical components and installation.

3. Single-Source Responsibility: Obtain same type of complete pumps from a single manufacturer with pumps, components, and accessories from a single source. Include responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

4. Design Criteria: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Engineer. The burden of proof for equality of pumps is on the contractor.

9.1.8 Delivery, Storage, and Handling

1. Store pumps in a clean, dry location, retain shipping flange protective covers and protective coatings during storage and protect bearings and couplings against
damage from sand, grit, or other foreign matter.

2 For extended storage greater than 5 days, dry internal parts with hot air or a vacuum producing device. After drying, coat internal parts with light oil or kerosene. Dismantle bearings and couplings, dry and coat with an acid-free heavy oil, and tag and store in a dry location.

3 Comply with pump manufacturer's rigging instructions for handling.

9.2 PRODUCTS

9.2.1 Manufacturers

1 Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal.

9.2.2 Pumps General

1 Factory assembled and tested pumps of construction required for permanent installation with single NEMA MG 1 motor with type of enclosure and electrical characteristics indicated. Include built-in thermal-overload protection and grease lubricated ball bearings. Motors are non overloading within full range of pump performance curves.

2 Apply manufacturer's finish paint to factory-assembled and tested pump sets prior to shipping.

3 Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anti-corrosion compound after assembly and testing. Protect flanges, pipe openings and nozzles with wooden flange covers or with screwed in plugs.

9.2.3 Submersible Pump Sets

1 Submersible direct connected type with a guide rail system and basin or pit cover suitable for supporting controls. Include holes with seals in slab as required.

2 General Description: Centrifugal, end suction single stage drainage pump with motor and operation controls.

3 Impeller: ASTM A 48, Class No. 25 A or higher cast iron, statically and dynamically balanced, multi-vane nonclog design, overhung, single suction, keyed to shaft, and secured by locking capscrew.

4 Pump Arrangement: Duplex.

5 Casing: Cast iron, with discharge quick coupling arranged to connect to guide-rail system discharge elbow fitting.

6 Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball
bearings.

7 Seals: Double mechanical seals.

8 Motor: Hermetically sealed capacitor-start type, with built-in overload protection. Include a lifting eye or lug, and a 3-conductor waterproof power cable of length required, but not less than 6 m with a grounding plug and cable-sealing assembly for connection at pump.

9 Moisture Sensing Probe: Include an internal moisture sensor, a waterproof cable of length required but not less than 6 m with a cable sealing assembly for connection at pump, and a moisture alarm.

10 Guide Rail System: Include the following

11 Guide Rails: 2 galvanized-steel or other corrosion resisting vertical pipes or structural members attached to stationary elbow.

12 Stationary Elbow: Fixed discharge elbow fitting with flange that matches to pump discharge and support.

13 Lifting Cable: A chain Stainless steel cable or chain attached to pump and basin cover at manhole.

14 Pump Discharge Piping: Pressureized UPVC pipes and fittings, flanged connections when exposed and push-on joint for underground piping.

15 Controls: Wall mounted, in a NEMA 250, Type 1 enclosure. Controls consist of 5 mercury float switches in NEMA 250, Type 6 enclosures, mounting rod, and electric cables. Include an automatic alternator to alternate operation of pump units on successive cycles.

16 High-Water Alarm: Rod-mounted, NEMA 250, Type 6 mercury float switch alarm matching control, with electric bell. Operation is 120 volts a.c. with transformer and contacts for remote alarm bell.

17 Control Panel: Weatherproof panels for outdoor installation and standard panels for indoor installation constructed of sheet steel and each equipped with main isolator, busbar system, lightning arrester (for outdoor installation), under voltage and phase protection, direction of rotation monitoring, output isolators interlocked, starters, transformer, static frequency inverters, alternator.

18 Mount on panel Hand-O-Auto switch, warning and indicating lamps, high level alarm horn with provisions for remote signals, to BMS system. The following signals shall actuate the BMS for each ejector/sump pump.

(a) Start/stop
(b) On/off
(c) Normal/fault
9.2.4 General Duty Valves

1 Refer to Section 19 part for Valves for general duty gate, ball, butterfly, globe and check valves.

9.2.5 Ejector Basins and Sump Pits

1 Pits shall be constructed of cast-in-place concrete. Include curb frames and covers of ductile iron, curb frame with bitumastic coating of angle-cross-section shape with flat top surface and dimensions to fit cover. Provide covers with double seals, pumps, pump shafts, control rods, discharge piping, vent connections, and control and power cables where indicated.

2 Include painted steel or cast-iron reinforcing covers capable of supporting the traffic loads.

9.3 EXECUTION

9.3.1 Examination

1 Examine areas equipment foundations and conditions for compliance with requirements for installation and other conditions affecting performance of pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

2 Examine roughing-in of plumbing piping systems to verify actual locations of piping connections prior to pump installation.

9.3.2 Earthwork

1 Excavating trenching and backfilling are specified in Earthwork structural specifications.

9.3.3 Concrete

1 Construct concrete basins of shapes and dimensions indicated.

2 Concrete for pits is specified in Cast-in-Place Concrete structural specifications.

3 Construct concrete basins in locations indicated and connect to drainage piping and vent piping. Refer to (Cast-in-Place) Concrete for concrete work. Set cover so top surface of cover are flush with finished floor for indoors installation, walkways and roads, and are 150 mm higher than ground finished level for outdoors installation where traffic is not disrupted.
9.3.4 Installation

1. Comply with pump manufacturer's written installation instructions. Install pumps in locations indicated and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings and accessories. Support piping so that weight of piping is not supported by sump pumps, make direct connections to drainage piping. Install guide rail systems. Install pumps so that pump and discharge pipe disconnecting flanges make positive seals when pumps are dropped into place.

9.3.5 Connections

1. Connect piping to pumps as indicated. Install valves that are same size as piping connecting to pumps. Install discharge pipe sizes equal to or greater than diameter of pump nozzles. Install check valve and gate valve on each sump pump discharge.

2. Install electric connections for power controls and devices according to Electrical Specs.

9.3.6 Adjusting

1. Set pump controls for automatic start, stop and alarm operation as required for system application.

9.3.7 Commissioning

1. Final Checks Before Start-up: Perform the following preventive maintenance operations and checks before startup.

2. Lubricate oil lubricated type bearings. Remove grease lubricated bearing covers and flush bearings with kerosene and thoroughly clean. Fill with new lubricant according to manufacturer's recommendations. Disconnect couplings and check motors for proper rotation. Rotation shall match direction of rotation marked on pump casing. Check that pumps are free to rotate by hand. Do not operate pump if bound or even drags slightly, until cause of trouble is determined and corrected. Check that pump controls are correct for required application.

3. Starting Procedure: For pumps with shutoff power not exceeding safe motor power:-

   (a) Start motor.

   (b) Open discharge valves slowly.

   (c) Check general mechanical operation of pumps and motors.

9.3.8 Spare Parts

1. Hand over to the Employer the spare parts and tools required for operation and maintenance as recommended by the manufacturer to cover a working period of
two years. In addition, submit to the Employer, for approval, a priced list of the above recommended spare parts and tools for an additional period of three years. The list should nominate the above required items. The approved list shall be part from the operation and maintenance manuals.

9.3.9 Data Sheet

1 For Each Site of the five sites sump pumps equipment data sheet details and exact locations; kindly refer to both different sites drawings and the equipment’s schedule on the following drawings:

(a) Al Khor Site : Dwg. No. P-41-601.
SECTION 21

ELECTRICAL WORKS
1. GENERAL PROVISIONS FOR ELECTRICAL Q11025-0100D

1.1.1 Scope

Delete Sub-Clause 1.1.1-1 and replace with the following new Sub-Clause

1 The electrical Installation Contractor herein referred to as the “Contractor” within this part and all other electrical parts of the various electrical Sections 21 and 23 of these specifications shall carry out all electrical works complete in accordance with the requirements of the Project Documentation.

Delete Sub-Clauses 1.1.1-2 (b & d) and replace with the following new Sub-Clause

(b) Builder's work in connection with the Electrical Installations, including supply, necessary inserts, sleeves, fire sealants, etc.

(d) The supply and installation of cables, conduits, boxes and termination points, for the motors, starters, controls and the like for the Heating, Ventilation and Air-conditioning, Plumbing services, etc. unless stated otherwise in specific sections.

Delete Sub-Clause 1.1.1-2 (h) and replace with the following new Sub-Clause

(h) Arranging and carrying out all necessary approvals with the Qatar Civil Defence Department for the Fire Alarm System.

1.1.2 Regulations

Delete Sub-Clause 1.1.2-2 (g) and replace with the following

(g) Rules of the Qatar Civil Defence Department for Fire Alarm Installations.

1.1.5 Shop Drawings

Add to Clause 1.1.5-5 the following

(l) Layout drawings for the substations showing the actual locations of equipment, dimensions, clearances, cables routing, details and type of fittings, etc.

1.1.7 As Built Drawings

Add to Clause 1.1.7 the following

3 Contractor to coordinate with the Engineer regarding the software version to be used for the above submittals.

1.1.10 Equipment and Materials Approval

Add to Clause 1.1.10 the following

6 All material shall be represented by a Local agent and should be registered with
the ministry of Commerce and industry and agency certificate shall be furnished. They must have the facilities available for servicing the equipment and are maintaining adequate stocks of spares.

7 Contractor to confirm availability of equipment and materials proposed for use in the work prior to submission for approval. If, after approval, equipment or materials cease to be available, submit alternative items of equal quality and type for approval.

8 Contractor to confirm that proposed equipment and material characteristics where required are compatible with the requirements of the Local Power Authority or other authorities having jurisdiction and are acceptable to them. Inform the Engineer of any modifications necessary to comply with the Local Power Authority's requirements.

9 Listing of approved manufacturers in the Specification does not necessarily constitute approval of their standard products as equal to those specified. Ascertain that listed manufacturers are able to supply equipment and material in conformity with the Specification.

10 Equipment generally is to be supplied in complete factory assembled units ready for installation on site. Disassembly necessary for transportation or other purposes is to be arranged to limit site work to simple re-assembly and inter-wiring of control and power cabling.

11 Equipment and materials are to be stored in an approved location, under cover, free from humidity, dust, debris and rodents. Equipment sensitive to heat and humidity is to be kept in climatically conditioned areas until installed and handed over.

12 The Employer reserves the right to operate operable defective equipment during the Defects Liability Period until it can be removed from service for repair or replacement.

### 1.1.17 Equipment duties & Rating

*Delete Sub-Clause 1.1.17-2*

### 1.1.20 Segregation of Services

*Add to Clause 1.1.20 the following*

5 Other low current systems

   (a) Keep the minimum distances required by the standards between power and low current systems.

### 1.1.22 Polarity

*Add to Clause 1.1.22*

4 In all cases, Contractor to check with QGEWC for the phase colours to be adopted throughout the installation, prior to purchasing any related equipment, accessory or material.
1.1.24 Spare Parts

Rename Sub-clause 1.1.24-2 as “Main MV Switchboards – MDB”

Add Clause 1.1.28 Special Requirements for Electronic Equipment

1. Electronic components of communication systems, security systems and special systems and electronic components forming part of the power generation and distribution system are to be solid-state integrated construction, unless otherwise approved.

2. Manufacturer is to indicate maximum and minimum ambient temperatures acceptable for the equipment to operate continuously and normally and beyond which electronic components may suffer permanent damage. Contractor is to coordinate the air conditioning requirements for the rooms where the equipment is located. Inform the Engineer of any special requirements or discrepancies for a decision.

3. Alternative Electronic Equipment may be submitted for approval, provided such equipment meets or exceeds the functional capabilities and/or performance parameters of the equipment specified. Proposals for alternative equipment will be considered only if accompanied by the following information:
   (a) List of operational characteristics and performance parameters
   (b) List of differences in operation and performance between proposed and specified equipment
   (c) List of changes required and resulting implications
   (d) Drawings indicating changes required to system wiring
   (e) Statement of advantages of proposed equipment over that specified.

4. Solid State Equipment, under normal conditions, of operation is to withstand any surges, which might be produced by sudden mains or standby power switching operations. Protective devices are to be provided to protect against surges, failure of output stages due to open circuit, short-circuit or mismatch. Comply with IEC standards. System/equipment which may be adversely affected by short duration power blackouts shall be capable of riding through such a disturbance by having an internal battery back up to the memory / microprocessor, etc.

5. Indicator Lights other than MV pilot lamps are to be light emitting diodes (LEDs).

6. Electromagnetic Relays and control/small power transformers are to be designed to withstand the 500 V a.c. test voltage between winding and winding or winding and core.

7. Dust Covers, easily removable for inspection and servicing, are to be provided for all relays and sensitive elements.

8. Outdoor Equipment is to be designed for maximum ambient temperature in direct sun and is to be protected/enclosed, as applicable, against dust and weather conditions.
9 Contractor to carry out field investigations and tests to determine possible interference from outside sources. Design electronic equipment to ensure trouble-free operation.

10 Power Supply Units for low current systems which are fed from the MV supply are to be independently fused on the live conductor and are to have front panel mains indicator light, on/off switch and standard cartridge type fuse holder. Blown fuse indicator lamp is to be provided when fuse does not have an indicator.
2 MV FACTORY BUILT ASSEMBLIES (FBA’s)

2.1 GENERAL

2.1.1 Scope

Delete Sub-Clause 2.1.1-2 – Part 7 and replace with the following

Part 7 Conduit and Conduit boxes

2.1.3 References

Delete the following in sub-clause 2.1.3-1 and replace by the following

<table>
<thead>
<tr>
<th>Delete</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 142</td>
<td>BS60255</td>
</tr>
<tr>
<td>BS EN 6094</td>
<td>BS EN 60947</td>
</tr>
<tr>
<td>IEC 185</td>
<td>IEC 60044-1</td>
</tr>
<tr>
<td>IEC 337-2</td>
<td>IEC 60947-5</td>
</tr>
<tr>
<td>BS 37 Pt. 1</td>
<td>BS 5685</td>
</tr>
<tr>
<td>IEC 51</td>
<td>IEC 60051</td>
</tr>
<tr>
<td>IEC 521</td>
<td>IEC 62052</td>
</tr>
<tr>
<td>IEC 157-1</td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>IEC 408</td>
<td>IEC 60947-3</td>
</tr>
</tbody>
</table>

2.1.4 Submissions

Delete Sub-Clause 2.1.4-2-(b) and replace with the following new Sub-Clause

(a) Type test certificates of all components and whole assemblies from an internationally recognized testing authority or from an approved independent testing lab in accordance with IEC 61439.

2.1.5 Quality Assurance

Add Sub-Clause 2.1.5-3

3 All Assemblies are to be manufactured by international manufacturers. Local manufacturers must be listed as approved by QGEWC and holding a certificate of ‘panel assembler from the original international manufacturers.

2.2 PRODUCTS

Cubicle Switchboards (MDB’s)

Add to sub-clause 2.2.1-1 the following

(y) Generally: Main distribution boards shall be dead-front type, metal enclosed, multi-cubicle, floor mounted, free standing, with 1000V rated insulation voltage, and 600 V rated operational voltage, with fully withdrawable and motorized main breaker and fixed outgoing breakers sections, manually or manually and electrically operated, as shown on the Drawings, with matching vertical sections to form a continuous integral and
rigid structure. All components are to be suitably rated for continuous operation at 50 deg. C (122 deg. F).

(z) Coordinate with Building Management System (BMS) supplier and provide all necessary interfaces, relays, transducers, etc, with cabling, necessary for the functions specified in the BMS schedules and/or shown on the Drawings.

(aa) Meters where provided shall be capable of connection to BMS. Coordinate with BMS supplier for proper interfacing.

Delete sub-clause 2.2.1-2 and replace with the following new Sub-Clause

(a) Rigidly framed and bolted, with electro-galvanized sheet steel enclosures, minimum thickness 2 mm, phosphatized, primed with rust inhibiting primer and finished with thermal polymerized polyester epoxy powder coating, grey colour (RAL 7032) from outside and inside with white colour, to approval. Switchgear is to be vermin, dust and rodent proof, IP 54 protection to IEC 60529 for indoor installation with adequate lifting means and base frames and capable of being moved into position and directly bolted to floor without additional sills.

(b) Main Distribution Board Type: Switchboard(s) are to be of the following type(s):

(i) Form 4b or form 4 type 7 to IEC 61439 in accordance with QGEWC requirements.

(ii) Accessibility: Front accessible.

(iii) Alignment: Front and rear aligned.

(iv) Incoming breaker: Withdrawable, motorized power air circuit breaker (PACB).

(v) Outgoing breakers: MCCB fixed type. Access to the internal components of any compartments must be feasible by isolating its particular switch. The hinged doors shall be mechanical; interlocked with the switch in such a manner that the door can be opened only in the “OFF” position.

(c) The switchgear shall be provided with suitable cable glands to suit the type, size and number of cables as indicated on the drawings.

(d) Ventilation: Compartments are to be ventilated, by approved methods complying with the Standards.

(e) Main distribution boards are to have a short circuit withstand current greater than the prospective fault level at the location and for a minimum of 3 sec and for a minimum of 44 kA for 3 sec and as stipulated in QGEWC regulations. All boards shall comply with IEC 61641 for internal arcs. Breakers shall be selected to the “service level”.

(f) PLC based auto-change over logic to be built in case of one transformer failure with a provision for local and auto control. Provision shall also be made for momentary coupling of both incomer feeders by means of keyed manual control selector switch.

(g) All ACBs to be category B. The whole installation to be fully rated for
prospective fault at the location and selectively coordinated such that breakers from different manufacturer can be used.

(h) Fastenings between structural members are to be bolted.

(i) Extension of structure and busbars is to be possible at either end of switchboard. The electrical installation is to be fully rated for prospective faults at the location and selectively coordinated.

(j) Arrangement is to permit incoming and outgoing busbars and cables to enter enclosure as indicated on the Drawings and connect at respective terminals without inconvenience to installation or maintenance.

(k) Removing Circuit Breakers: Suitable arrangements and equipment are to be provided for extracting, lifting and unloading switchgear from enclosures as appropriate for type of switchgear.

(l) Spare Position shall be fully equipped enclosure with switchgear.

(m) Main incomer shall be provided with surge protectors as per QGEWC specification.

(n) Fully withdrawable metal enclosed circuit breaker section is to consist of compartmented unit(s), stationary part with rear busbar and cable connection compartments and front draw-out circuit breaker assembly. Partitions between sections are to be bolted steel plate and partitions between compartments are to be tough solid insulating removable bolted barriers. Each unit is to have hinged lockable front door with grip-handle and door mounted instrumentation. Shutters to be provided to ensure full protection against live contact.

(o) Pull Sections: An additional cable pull section is to be provided, depending on actual configuration shown on the Drawings, and subject to the Engineer’s approval.

(p) The height of the switchboard shall be limited to 2200mm unless specifically required to meet the site constraints. Proposal shall be approved in writing by the engineer.

2.2.1-8 Instruments

Delete Sub-Clause 2.2.1-8 (a) (i) – Point 7 and replace by the following:

Three ammeters shall be provided to read the current of each phase.

Add to Sub-Clause 2.2.1-8 (a) the following

(ii) Main functional display unit (MFDU)

Provide a main functional display unit (MFDU) to provide readings similar to those mentioned above in (i). Ensure a communication link with the BMS.

2.2.3 Submain Distribution boards (SMDB)

Delete clause 2.2.3 and replace with the following

1 Type: General purpose type or industrial suitable for relevant ambient conditions, flush self standing and or surface mounted as shown on the drawings, comprising box, trim, or trim and door to approved manufacturer’s standards and sizes.
Enclosure shall be subjected to 1000-hour salt spread test.

2 Construction: Box, trim and doors, where required, are to be electro-galvanized sheet steel of gages not less than specified and in accordance with the standards. Welded joints are to be galvanized after manufacture. Thickness of the steel sheet shall be not less than 1.5 mm. Gutter spaces are to conform to the standards, adequate for the utilized cables/wires subject to the Engineers’ approval and in no case less than 100 mm on all sides. Enclosure is to have pre-designed angles or threaded end studs to support and adjust mounting of interior panelboard assembly.

3 Trims are to cover and overlap front shield, covering all terminals and bus compartments, to form a dead front panel. Trims are to be fixed to cabinet/box by quarter-turn clamps engaging flange of box (use of screws engaging holes in flange of box is not acceptable). Screws where used are to be oval-head, countersunk and flush. Trims for flush mounted panelboards are to overlap box and front shields by at least 20 mm. Trims for surface mounted panelboards are to be exactly sized to form flush fit to box.

4 Doors are to have concealed hinges integral with trim, and flush combination cylinder lock and catch. Doors over 1000 mm high are to have vault-type handle and multiple point latch mechanism. Locks are to be keyed alike.

5 Hinged Front Panels: Allow access to breaker, metering, accessory, and blank compartments, maximum demand indicators (MDI) on incomer.

6 Finish: Inner and outer surfaces of cabinet/boxes, trims, doors etc. are to be cleaned, phosphatized, chrome passivated and treated with final thermosetting epoxy powder modified by polyester resins providing high resistance to mechanical injury, heat, acid and alkali solvents, grease, aging and corrosion and of standard grey RAL 7032 outside and white inside colour to the approval of the Engineer.

7 Directories under glassine, or an approved alternative durable arrangement, are to be provided on inside face of doors, or in metal label holders when trim without doors are specified. Directories are to be typed to identify panelboards and clearly indicate circuit number and description of load.

8 Outdoor enclosures are to be heavy duty double walled aluminium cabinets, minimum 1.5 mm thick, fully weatherproofed (IP 55), without knockouts, but with removable sealed/gasketed bottom gland plates and gasketed doors.

9 Glands: Cable glands used for armoured cables are to be of brass compression type, complying with BS 6121 and BS EN 50262: Part 1, with earth tag and PVC shroud.

10 Operating dollies of all circuit breakers/isolators to be door interlocked and it shall be possible to defeat the interlock by means of a tool.

11 Busbars

(a) Type: One piece, 98 percent pure electrolytic high conductivity copper, tinned, based on total maximum operating temperature of 90 deg. C (194 deg. F) at any point of the bus, at full continuous rating. Bolted or clamped
contact surfaces are to have maximum current density not exceeding requirements of the approved standards. Aluminium is not to be used for busbars or panelboard parts.

(b) Design: Shrouded/insulated and rigidly designed so that branch circuit devices can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping. Busing is to be full size without reduction. Busing and blank plates are to allow installation of future circuit devices, where indicated on the Drawings. DP’s shall be provided with 4 poles vertical busbars/risers.

(c) Rating: At least equal to main-circuit breaker frame size. Where no main circuit breaker is required, busbars are to have main lugs or disconnect switch, with nominal rating equal to standard circuit breaker frame sizes, and as shown on the Drawings.

(d) Unless otherwise stated in the particular specification or drawings, the short circuit duty shall be minimum 25 kA for 3 sec. and it shall also carry at least 125 percent of the maximum short circuit level at point of application for 3 seconds, without showing any signs of degradation.

12 Terminals and connections are to be anti-turn, solder-less screw-pressure type. Screws and bolts used for making copper/copper connections are to be hard copper alloy with lock washers (riveted bus connections are not acceptable).

13 Neutral bar is to be solid fully rated and fully insulated from cabinet or box. One solder-less box type set-screw connector is to be provided for neutral wire of each branch circuit and one bolted clamp-type connector or anti-turn lug with set-screw for main incoming neutral wire. Neutral is to be fully sized and rated as for phase busbars.

14 Earthing bar is to be copper on the full length switch board, brazed to panelboard cabinet, with bolted pressure connector for main conductor and 1 set screw-type tunnel terminal for each outgoing conductor, to provide secure and reliable contact with all metal parts and enclosure.

15 Three ammeters with dead pointer to indicate the maximum reading and one 0-500 Volt voltmeter with Off/ph-ph/ph-N selector switch, for incoming supply.

16 All breakers shall be of the MCCB type except for those of frame above 630A which shall be of the ACB type.

17 All MCCB of rating 100 Amps and above shall have adjustable thermal and magnetic facilities.

18 MCCB rated 400A and above shall have electronic trip units.

Delete clause 2.2.4 and replace with the following new clause

2.2.4 Final Branch Panelboards – Distribution Boards (DB) - Type MCB

1 Arrangement: Comprise set of homogeneous branch circuit breakers with unified profile and base, and one main circuit breaker or switch as shown on drawings. Single and multi-pole circuit breakers or other devices are to occupy modular spaces. Accommodation of contactors and split-bus arrangement or other devices is not to change regularity of standard box width.
2 Indoor Enclosure: Sheet steel, minimum 1.0 mm thick for box/cabinet and minimum 1.5 mm thick for front shield, trim and door. Fixings for flush trim are to be adjustable to allow for mis-alignment between box and wall surface. Wiring spaces (gutters) are to be at least 100 mm wide. Larger gutters are to be provided where tap-off insulated split connectors are required. Knockouts are to be provided in top or bottom of enclosures and are to provide a neat and uniform conduit/cable terminal arrangement.

3 Internal Assembly: Comprise removable back plate or back pan of rigid construction, attached to enclosure by four captive screws through keyhole fixings, and provided with DIN rails in horizontal arrangement for SPN panels and in vertical arrangement for TPN panels. Assembly is to be complete with neutral terminal block, earthing bar and 1 piece insulated bolt-on/comb-type phase busbar. Busbars are to be single phase or 3-phase with spade connectors for fixing by tightening a single screw on circuit breaker. Insulation is to be high thermal rating, capable of carrying maximum short circuit current for 1 second without overheating beyond acceptable limits required by the Standards. Panelboards are to comply with BS EN 60439-3.

4 SPN type panelboards are to be suitable for 240 V maximum service voltage, single-phase and neutral, with MCB’s on branch circuits and main incoming of the miniature type.

5 SPN type main circuit breaker or isolator is to be double-pole, as shown on the Schedules.

6 Single-pole and double-pole MCB’s for 240 V service, are to have trip ratings between 6 A and 50 A, with ICs as required in the Schedules.

7 TPN type panelboards are to be suitable for up to 415 V A.C. maximum service voltage, 3 phase and neutral, with MCB’s on branch circuits and 3 or 4 pole MCS main incoming, as specified or shown on the Drawings.

8 Triple pole branch circuit breakers are to have trip ratings between 5 A and 100 A, with IC as required in the Schedules.

9 TPN type panelboard main incoming is to be MCS, with/without RCD as shown on the Drawings.

10 Panelboards are to be protected against earth fault current, in addition to over current and short circuit protection, on each outgoing circuit, in accordance with the Regulations.

11 All panels shall comply with IEC 60641 for internal arcs (minimum time to be specified by Consultants).

12 Unless otherwise stated in the particular specification or drawings, all final Branch Panel Boards (MCB type) shall be rated for a short circuit rating of 12 KA and type test certificate furnished.

13 Each DB shall have separate earth and neutral bars having the same number of connection as there are for phase connections. A cable connection shall be made from earth bar to the incoming cable gland earth tag. All phase and neutral bars shall be sized to carry the full load current of the controlling breaker which shall
be of flat tinned copper rigidly mounted, supported on shock-resisting, non-hygroscopic, high grade insulators with high resistance to tracking, not subject to mould growth or termite attack with adequate spacing and clearance.

14 Connection from the bus bars to the breakers shall be made by using solid circular insulated conductors or insulated and tinned copper strip neatly set and formed. Each connection to or from a phase or neutral bar shall have its own brass fixing screws, washers, butts and locknuts.

15 Each distribution board shall be fitted with an identification label on its front cover. The label shall be suitably inscribed stating the distribution boards reference number/letter, rating in volts & amperes and the number of ways in English and Arabic. In addition to the above a reference card shall be fitted inside the distribution board giving details of each circuit, MCB size, cable size and location. The reference card shall be affixed to the inside of the distribution board’s door via a transparent envelope.

16 Distribution Boards (DB) located remote from the main switch boards shall be mounted at a height of not less than 1200mm from finished floor level to bottom of the DB maximum height of this DB shall be 2200mm from finished floor level to top of DB.

17 All live terminals of parts and bus bars shall shrouded with insulating materials to ensure that it is impossible for any live metal to be touched while withdrawing or replacing MCBs.

18 The correct rating of breakers shall be fitted in each way to conform to the size of the final circuit conductor and its connected load in conformity with KAHRAMAA.

19 All breakers and DBs shall be of one make throughout the whole of the works.

Add the following Clause

2.2.5 Digital Multi-meter (DM)

1 General Provision

(a) All setup parameters required by the DM shall be stores in non-volatile memory.

(b) The DM shall support single phase and three-phase, three – or four-wire systems with nominal frequencies of 45 to 65 Hz without modification.

(c) The DM shall comply with installation category III pollution degree 2 for distribution systems up to 277 V L-N/480 VAC L-L.

2 Measured values: The DM shall provide the following, true RMS metered quantities:

(a) Real-time readings: Current, Voltage, Real Power, Reactive Power, Apparent Power, THD (V and I).

(b) Energy Readings: Accumulated Energy (Real KWH, Reactive KVARh, Apparent KVAh).
(c) Demand and peak Readings: Current, Real Power, Reactive Power, Apparent Power.
(d) Other: Power Factor, Load Operating Time.

3 Sampling: The Current and Voltage Signals Shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15th harmonic.

4 Minimum and Maximum Values: The DM shall provide minimum and maximum values with phase indication via communications and display for the following parameters: Voltage, Current, Power Factor, Real Power Total, Reactive Power Total, Apparent Power Total, THD (Voltage and Current) and Frequency.

5 Voltage and Current Inputs
(a) The Circuit monitor shall allow direct connection to circuits up to 480 volts AC L-L with a 20% over range capacity and 2 Mohm (L-L) or 1Mohm (L-N) of voltage input impedance. The DM shall also accept voltage inputs from standard instrument potential transformers with primaries up 1.6MV.
(b) The DM shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 0-6 amps with the following withstand currents: 15 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.

6 Accuracy
(a) Frequency accuracy shall be ± .01 Hz from 45 to 65 Hz.
(b) No annual calibration shall be required to maintain this accuracy.

7 Control Power: The PM shall operate with the following auxiliary power 110-415 VAC, ± 10% or 125-250 VDC, ±/− 20%.

8 Display
(a) The DM display shall be a back lit LCD, anti-glare and scratch resistant.
(b) The DM display shall be capable of providing four values on one screen at the same time. A summary screen shall provide average current, average voltage, power and energy values in a single view.
(c) The DM shall provide an intuitive navigation with context-sensitive menus for easy to use.

9 The DM shall interface with the BMS.
3. PROTECTIVE DEVICES

3.1 GENERAL

3.1.4 Standards

Delete Clause 3.1.4 and replace with the following new Clause

The following standards shall be compiled with:

- BS88 Cartridge fuses
- BS EN 60269, IEC 60269 Cartridge fuses for voltages up to and including 1000VAC and 1500 V AC
- BSEN 60947, IEC 60947-2 Low Voltage circuit breakers
- BS EN 60898, IEC 60947-2 Miniature and Moulded Case Circuit Breakers
- BS EN 60255-6, IEC 60255 Electrical relays
- BS EN 60898 Electrical Relays
- BS EN 61008-1 Earth Leakage circuit breakers

3.2 PRODUCTS

3.2.2 Moulded Case Circuit Breakers

Delete Sub-Clause 3.2.2-7 and replace with the following new Sub-Clause

7. Breakers shall be completely enclosed in a moulded case to IEC 60947-2, suitable for installation inside switchboards.

Delete Sub-Clause 3.2.2-12 and replace with the following new Sub-Clause

12. In MCC applications, each MCCB shall be housed in a separate Compartment with the operating handle door interlocked when used as an Incomer, feeder or motor starter isolator, so that access can only be gained to the Compartment with the MCCB in the OFF position. Padlocking shall be provided in the OFF position only. When the MCCB is used for control transformers, distribution or ICA compartments the handle shall be internally mounted with appropriate shrouding and warning labels.

Add to Clause 3.2.2

16. MCCB’s located in SMDB’s shall have a utilization category “B” and are to have rated service short Circuit-breaking capacities (Sequence II) with suitably selected frame sizes.

3.2.3 Miniature Circuit Breakers

Delete Sub-Clause 3.2.3-1 and replace with the following new Sub-Clause

1. These shall be Type C for general purpose uses, suitable for the load they feed, and shall have a minimum short circuit rating as the rating indicated for the...
distribution board, unless otherwise specified in the Project Documentation.

3.2.5 Earth Leakage Circuit Breakers (ELCB)

Delete Sub-Clause 3.2.5-2 and replace with the following new Sub-Clause

2 The ELCB shall also provide high degree of protection against earth leakage, fire and electric shock. It shall withstand at least the minimum short circuit rating specified in the project documents. The breakers shall comply with BS EN 61008-1 and the recommended specification CEE 227 of the IEC on rules of approval of electrical equipment.

Delete Sub-Clause 3.2.5-5 and replace with the following new Sub-Clause

5 The breaker shall be mounted in the panelboard enclosure.
4. Motor Starters

4.2 PRODUCTS

4.2.1 Starters

*Delete Sub-Clause 4.2.1-4 (b) and replace with the following*

(a) 1 no. starter, comprising one of the following types, as indicated on the project drawings:

(i) Direct on line

(ii) Star Delta

(iii) Reduced voltage “soft start”

(iv) 2 speed

*Delete Sub-Clause 4.2.1-4-(i).*

*Delete Sub-Clause 4.2.1-6-(a) and replace with the following new Sub-Clause*

(a) 3 no. ammeters, 96 X 96, with 240° scale fitted with suppressed scale to read motor running and starting current, with an adjustable red pointer to indicate full load current. The scale range shall be such that normal full load current gives approximately 60% full scale deflection.

*Delete Clause 4.2.4 Auto Transformer Starting*

*Delete Clause 4.2.5 Slip Ring Rotor Resistance Starters*

*Add to Clause 4.2.6*

7 The soft starter shall be supplied factory configured ready to commission, without requiring any reconfiguration at site.

8 The soft starter shall have the following protective feature as minimum:

(a) Over temperature

(b) Overload

(c) Jam

(d) Stall

(e) Phase Loss

(f) Phase reversal

(g) Shorted SCR

9 The soft starter shall have the following control feature as minimum:

(a) Kick start 0-85% locked rotor torque – 0 to 2 seconds
(b) Ramp start 0-85% locked rotor torque – 1 to 60 seconds
(c) Current limit start 0-85% locked rotor current – 1 to 60 seconds
(d) Soft drop 0 to 60 seconds

10 The soft starter shall be provided with high speed fuses as recommended.

Add the following new Clause 4.2.7

Combination Starters Switch Disconnectors

1 Components to comprise magnetic starter, switch disconnector and short circuit protection devices required by the Standards, in approved sheet metal enclosure to suit application.

2 Switch disconnector operating mechanism: quick make, quick break, with external operating handle mechanically interlocked with enclosure cover necessitating disconnecting switch to be in OFF position for access to inside of enclosure. Means are to be provided for by passing interlocks. Position of isolating switch to be clearly indicated on cover.

3 Short circuit protection gear to be moulded case circuit breakers of appropriate current interrupting capacity.

4 Operation of circuit breaker to be possible from outside of enclosure. Position of breaker ON/OFF/TRIPPED to be clearly indicated by position of handle.
6 CABLES AND SMALL WIRING

6.1 GENERAL

Delete Sub-Clause 6.1.2-1 and replace with the following new Sub-Clause

1 Cables and wires shall comply with the following standards as appropriate:

BS EN 10257: Part 1: Zinc or zinc alloy coated non-alloy steel wire, for armoring either power cables or telecommunication cables, land cables.

BS 5467: Specification for 600/1000V and 1900/3300V armored cables having thermosetting insulation.

BS 6004: Electric cables PVC insulated, non armored for voltages up to and including 450/750 volts, for electric power, lighting and internal wiring.

BS 6121: Mechanical cable glands.

BS 6234: Specification for polyethylene insulation and sheath of electric cable.

BS 6360: Specification for conductors in insulated cables and cords.

BS 6346: Specification for 600/1000 V and 1900/3300 V armored electric cables having PVC insulation.

IEC 60189-2: Cables in pairs, triples, quads, quintuples for inside installations.

IEC 60228: Conductors of insulated cables.

IEC 60287: Calculation of continuous current rating of cables (100 percent load factor).

IEC 60502-1: Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV.

IEC 60885: Electrical test methods for electric cables.

ISO9000: Quality Management and Assurance Standards

Delete Sub-Clause 6.1.2-2 and replace with the following new Sub-Clause

BS 1858: Electric cables accessories.

BS 6121: Mechanical cable glands. Armour glands. Requirements and test methods.

BS 6910: Cold pour resin compound and heat shrink cable joints in the voltage range up to 1000 V a.c. and 1500 V d.c.
6.2 PRODUCTS

6.2.2 Cables

Delete Sub-Clause 6.2.2-1 (f)

Delete Sub-Clause 6.2.2-2 (f) and replace with the following new Sub-Clause

(f) Insulation for each conductor shall be colour coded or otherwise identified, as required by the Regulations. Colour coding shall be maintained throughout the installation. Contractor is to check with QGEWC regarding adopted colour coding prior to any installation.

Add to Sub-Clause 6.2.2-2 the following

(i) Low Smoke and Fume (LSF, Low Smoke Zero halogen – LS0H) Material shall be extruded type, in compliance with BS 6724 / IEC 60754 for armoured cables and BS 7211 for unarmoured cables. Materials used in construction of LSF cables are to be nominally free from halogens (fluorine, chlorine and bromine). When material is tested in accordance with BS EN 50267, Parts 1-3 and IEC 60754, Part 1, the acidic gas evolved during combustion is to be less than 0.5% with smoke density within 40%. When tested in accordance with ASTM method S2863, the oxygen index of bedding and sheathing materials is not to be less than 35. Completed cable is to meet the requirements for tests under fire conditions when tested in accordance with BS EN 50265, Part 1 and BS EN 50266. Cores and cross sectional area are to be as shown on the Drawings. Cables shall comply with IEC 60331 and IEC 60332.

Add the following new Sub-Clause 6.2.5

1 Fire resistant LS0H Cable (similar to Prysmian - Type FP 200 Gold, or approved equal): Multi core solid or stranded plain annealed copper conductors to IEC 60228 (in sizes up to 4 mm²), fire resistant insulation, galvanized steel wire armored, category CWZ to BS 6387, PH60 classified to BS EN 50200, and 30 minutes rating when tested with additional water spray in accordance BS EN 50200 Annex E and complying with BS 7655, laminated aluminum screen and LS0H composite sheath with tinned earth continuity conductor/drain wire to IEC 61034 and IEC 60754 or BS EN 50267-2-1. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall be rated 300/500 V, capable of accepting voltage surges up to 5 kV, operating conductor temperature of 70 deg. C. Cable shall be used for fire alarm, voice evacuation installations, branch circuits in central battery system and other loads requiring category 1 circuits in accordance with BS 8519 including buildings with evacuation time not exceeding 30 minutes unless otherwise specified under fire alarm section and where shown on the drawings.

A. Fire resistant LS0H Cable 600/1000 V, (similar to Prysmian - Type FP-400, or approved equal): Multi core plain copper stranded circular or shaped conductor (sizes up to 400mm²) complying with IEC 60228 with fire resistant insulation category CWZ to BS 6387, category F2 to BS 7846, PH60 classified to BS EN 50200 and 30 minutes rating when tested with additional water spray in accordance with BS EN 50200 Annex E and
complying with BS 7655 operating conductor temperature 90°C, single galvanized steel wire armour and extruded low smoke zero halogen (LS0H) over sheath wire to IEC 61034 and IEC 60754 or BS EN 50267-2-1. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall be used for feeders of the fire pumps, smoke and pressurizing fans, fire fighting elevators and other firefighting and life safety loads requiring category 1 circuits in accordance with BS 8519 including buildings with evacuation time not exceeding 30 minutes and where shown on the drawings.
7 CONDUITS AND CONDUIT BOXES

7.1 GENERAL

7.1.3 Description

Delete Sub-Clause 7.1.3-2 (e) and replace with the following:

(e) Irrespective of service, conduit and fitting used shall be of galvanized steel type. Conduits from terminal box to machine shall be flexible steel conduit as per BS 731

7.2 PRODUCTS

Delete Clause 7.2.1

7.2.2 Rigid Steel Conduit And Fittings

Delete Sub-Clause 7.2.2-1 (b) and replace with the following:

(b) Conduits shall not be less than 20 mm internal diameter size, unless otherwise indicated, and shall be complete with all necessary threaded fittings, couplings and connecting devices having galvanized equivalent finish.
9 CABLE TRAYS

9.2 PRODUCTS

9.2.2 Materials

*Add to Clause 9.2.2 the following*

2 Bond trays carrying MV cables to earth with 16 Sq. mm. PVC insulated copper single core cable.
10  WIRING ACCESSORIES AND GENERAL POWER

10.2  PRODUCTS

10.2.2  Outlet Boxes

Delete sub-clause 10.2.2.1 header and replace with “metallic outlet boxes”

Add to Clause 10.2.2 the following:

3  Floor Boxes
   (a) watertight, cast iron or cast metal alloy with corrosion resistant finish, adjustable mounting, standard duty, round or square, factory drilled and tapped for required conduit sizes, and with brass cover and flange with brushed finish free from markings other than required for mounting screws

10.2.3  Switches

10.2.3.3  Switch Plates

Add to Sub-Clause 10.2.3-3 the following new Sub-Clauses

   (b) Brushed Stainless Steel plates: for use in all areas unless otherwise stated below.
   (c) Metal plates: heavy gauge, minimum 1 mm thick, metal clad finish, for use in substation, generator rooms.

Add to Clause 10.2.3 the following new sub-clause:

6  Switches are to be selected in accordance with the design documents.

10.2.3-4  Double Pole Switch

Delete Sub-Clause 10.2.3-4 (b) and replace it by the following Sub-Clause.

   (b) The face plate shall be brushed stainless steel in all areas

Add Sub-Clause 10.2.3-7

10.2.3-7  Fused Double pole Switch

(a) The double pole switch shall be with neon indication lamps and shall be rated 20A.

(b) The face plate shall be brushed stainless steel in public areas and white plastic in BOH and technical.

(c) Switches shall be certified for AC-23A duty.

(d) Switches shall be fitted with a 13 Amp Fuse link to BS 1362.
10.2.5.4 Socket Outlet Plates

*Add to Sub-Clause 10.2.5-4 the following new Sub-Clause*

(a) Brushed Stainless Steel plates: for use all areas related to unless otherwise stated below.

(b) Metal plates: heavy gauge, minimum 1 mm thick, metal clad finish, for use in substation, generator rooms.

10.2.5 Socket Outlets

*Add the following new Sub-Clauses*

6 Socket Outlets are to be selected in accordance with the design documents

7 Plugs: Compatible with type of non-standard socket outlet specified, break resistant, of impact resistant moulded insulating material (separable construction), with solid brass pins and cord grip and of shape providing easy hand-grip for removal.

8 Quantity

(a) Supply number equal to 10 percent of total number of non-standard type of socket outlet supplied.

(b) Fuses for standard British type sockets are to be standard 13 A cartridge fuses fitted in plug.
11 LIGHT FITTINGS

11.1 GENERAL

11.1.4 SUBMITTALS

Add to Clause 11.1.4.1 the following

3 Contractor to submit lighting calculations based on approved calculation software and demonstrate to the Engineer that proposed fixtures provide the required illumination levels.

11.2 PRODUCTS

Delete Sub-Clauses 11.2.1 & 11.2.2 and replace with the following new Sub-Clause

11.2.1 Lamps

1 Rated voltage of PL lamps is to be equal to nominal voltage of distribution network. Lamps with different rated voltages are not acceptable.

2 Straight Tubular Fluorescent Lamps: IEC 60081 (SSA 138 and SSA 139) and, unless otherwise specified, are to be electronic start type, bi-pin, rated as indicated in the fixture description and with improved fluorescent internal coating. Colour of light is to be ‘superb quality white’ equal to Philips Nb. 84 unless otherwise specified. Lamps are to be low energy type (T5 lamps) with tube diameter 16 mm. Guaranteed rated life is to be above 8000 hours and luminous output above the following:

- 1200 lumens for 14 W lamps (600 mm long)
- 2600 lumens for 28 W lamps (1200 mm long)
- 3300 lumens for 35 W lamps (1500 mm long)

3 PL-C Compact Lamps: Single ended, compact-miniature lamp, consisting of four narrow fluorescent tubes welded together, with integral instant starter and capacitor and with special two-pin plug-in base and socket. Guaranteed rated life is to be above 5000 hours and luminous output above the following:

- 900 lumens for 13 W lamps
- 1200 lumens for 18 W lamps
- 1800 lumens for 26 W lamps
- 2400 lumens for 32 W lamps

4 High Pressure Sodium Lamps: Type SONT (tubular), with guaranteed average rated life (down to 80 percent output) above 10000 hours, and having initial luminous output above the following:

- 5600 Lumens for 70 W lamps
- 15000 lumens for 150 W lamps
- 25000 lumens for 250 W lamps
- 50000 lumens for 400 W lamps

5 Metal Halide Lamps: Comprising quartz discharge tube enclosed in clear tubular...
hard-glass outer bulb, provided with quartz re-strike lamps which cut off when MH lamps reaches 60 percent of its lighting output, operating on same principle as all gas discharge tubes with iodide additives indium, thallium and sodium in the mercury discharge, to increase intensity in three spectral bands; blue, green and yellow-red with high colour rendering. Lamps are to be to IEC 60188 with E40 base. Guaranteed average life is not to be less than 10000 hours for lamps rated less than 400 W, and not less than 4000 hours for lamps rated 1000 W and above. Luminous outputs, after 100 hours burning, are to be above the following:

- 5500 lumens for 70 W lamps
- 12000 lumens for 150 W lamps
- 17000 lumens for 250 W lamps
- 32500 lumens for 400 W lamps

(a) Permissible base temperature is to be not greater than 250 deg. C (482 deg. F), and maximum bulb temperature not greater than 550 deg. C (1022 deg. F). Lamp burning position for 2000 W, 230 V lamp is to be possible up to 75 degrees.

6 Low Voltage Halogen Dichroic Lamps: are to be 12V, 20W/35W/50W as per the requirement. The lamps shall be provided with a certified UV stop and a clear flat glass sealed lens. Certified average rated life shall be not less than 4000 hrs. Colour temperature shall not be less than 3000°K.

7 LED Lamps: are to have an average rated life of 50,000 hrs at 70% of lamp lumen output. And shall operate at fixtures ambient temperature of 50°C.

11.2.2 Luminaires

1 General:

(a) Generally: Construction and wiring of fixtures are to comply with the Regulations and Standards. Fixtures are to be fabricated, assembled and wired entirely at factory. Manufacturer's name, factory inspection stamp and official quality label is to be fixed to each fixture supplied.

(b) Lighting Fixtures (Luminaires): Manufacturer's standard, as given in Lighting Fixture Schedules shown on the Drawings, or equal.

(c) Sheet Steel Housings: Not less than 0.6 mm thick, and thicker when required by the Specification or the Standards.

(d) Sheet Steel Reflectors: Not less than 0.6 mm thick.

(e) Aluminium Reflectors: Not less than 0.7 mm thick, unless otherwise approved.

(f) Fabrication: Metalwork is to be mitered, welded and ground smooth without tool marks or burrs. Flat metal parts are to be stiffened by forming grooves and edges during fabrication. Metal parts are to have finish free from irregularities.

(g) Rust-Proof Ferrous Base: Ferrous metal parts are to be bonderized (treated with corrosion resistant phosphate solution) and given an approved rust-inhibiting prime coat before application of final finish.

(h) Finish For Non-Reflecting Metal Surfaces: Approved baked enamel paint. Paint colour on fixture frames and trims are to be as specified or as selected.
by Engineer.

(i) Finish for Light Reflecting Surfaces: White baked enamel paint having reflection factor not less than 85 percent. Mirror reflectors, where specified, are to be highly polished, anodized aluminium with reflection factors not less than 97 percent.

(j) Mechanical Resistance of Finish: After finish has been applied on steel surfaces and cured, it is to withstand a 6 mm radius bend without showing signs of cracking, peeling or loosening from base metal.

(k) Resistance of Finish to Ultra-Violet: Withstand 72 hours exposure to an ultra-violet RS lamp placed 100 mm from surface without dis-coloring, hardening or warping, and is to retain the same reflection factor after exposure.

(l) Heat Resistance: Finishes, wires and accessories inside fixtures are to be certified materials to resist the temperatures or other conditions encountered in the fixtures (105 deg. C (221 deg. F) at least).

(m) Wiring inside Fixtures: Not less than 1.5 mm² or as specified, heat resistant wires and insulated for 240 V application. Insulation is to have acceptable characteristics to resist maximum temperatures inside fixtures (105 degrees C at least). Wiring is to be terminated on screw type, fixed, insulating, ceramic heat resistant 105 degrees C (221 deg. F) terminal blocks.

(n) Hinges: Fixtures with visible frames and hinged diffusers are to have concealed hinges and catches, and stainless steel retaining clips. Other alternative equally durable products may be submitted for approval.

(o) Suspension Aligners: Provided for pendant fixtures for axial, vertical and horizontal alignment. Vertical adjustment is to be minimum 25 mm.

(p) Recessed Fixtures: Constructed to fit into suspended ceilings without distorting fixture or ceiling. Plaster rings are to be provided for plaster or concrete ceilings.

(q) Outdoor Fixtures: Non-ferrous metal or specially moulded material for outdoor use.

(r) Removal of parts for maintenance is to be possible without removing fixture housing.

(s) All control gear shall be suitable for an ambient of 50 deg C (122 deg. F) and shall be from internationally reputed manufacturers.

(t) All fixtures shall be clearly labelled by manufacturer, clearly stating "MAKE", "MODEL" and country of manufacturer.

(u) Connector adaptor to be provided with each fitting male/female

(v) All luminaires shall be certified by the manufacturer for use in an ambient temperature of 50°C.

2 Fluorescent Fixtures

(a) Lamp Holders Generally: IEC 60400, heavy duty, moulded white plastic with non-corroding spring contacts.

(b) Lamp Holders for Industrial Fittings: Spring loaded turret type, heavy duty, dust protected.
(c) Ballast Rating: ballast is to be manufactured and certified for the specific lamp it controls and for operation from nominal power supply, with voltage and frequency equal to nominal voltage and frequency of distribution network.

(d) Electronic Ballasts is to be used in conjunction with tubular and compact fluorescent fixtures. Ballast is to consist of electronic integrated circuit design, instant start, operating at 20 to 60 kHz, providing at least 30% power savings over equivalent standard electromagnetic ballasts, power factor corrected to above 0.9, having less than 20% third harmonic distortion (on the input), with crest factor of 1.4 or better. Ballast is to meet the requirements of the FCC regulations for Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI) class A. Ballast is to incorporate in its design a feature to preclude premature failure caused by transients as per IEEE 587 category A.

(e) Electronic Ballasts are to be designed and constructed to maintain a case temperature not greater than 90°C when operated at a room ambient of 50°C when tested in accordance with applicable standards. Ballasts are to be as manufactured by Osram, Lutron, Philips, Helvar or other equal and approved, with service life in excess of 10,000 hours. Use the most efficient combination of four, three, two and/or single lamp ballasts as recommended by the manufacturer and subject to the Engineer’s approval.

(f) Electronic Ballast Sound Rating: all ballasts are to be the manufacturer’s best (quietest) sound rating, with the rating clearly indicated on the ballast case. Ballasts found by the Engineer to be unduly noisy shall be replaced without charge prior to acceptance of the job.

(g) Electronic Ballasts are to be designed for single frequency operation, nominal 60 Hz, and are to be operated at the specified power supply voltage. Ballasts are to be firmly in the lighting fixtures to prevent vibrations.

(h) Remote Ballasts are to be furnished in rated enclosures ready for mounting and connection. Enclosures, with more than one ballast, are to be furnished pre-wired. Provide acoustically isolated mounts for remote ballasts and ballast enclosures to assure quiet operation.

3 High Intensity Discharge Lamp Fixtures

(a) High Intensity Discharge (HID) fixtures are to be complete units including integral ballasts (and ignitors for HPS lamps where indicated) and lamps of required number and type, and are to have lighting distribution characteristics equivalent to model and manufacturer indicated in the fixture description.

(b) Accessories: fixtures are to have mounting accessories, such as suspension rods or chains, rails or brackets, and protective glass covers with gaskets for protection against dust and humidity or type of corrosive atmosphere predominant in the location.

(c) Ballasts and Ignition Devices are to be power factor compensated to at least 0.9 lagging, and type specially selected for lamp type and size used. Ballasts are to be constant wattage, autotransformer type, designed for single frequency operation, nominal 60 Hz, and operated at the specified power supply voltage. Lamp is to be able to start with at least +/-10% variation from nominal line voltage and continue in normal operation with dips attaining 20% for four seconds. Compensation is to ensure there is no
great increase in operating current during starting and that gear losses do not exceed 10% of normal wattage. RF suppression circuit is to be provided.

(d) Ballasts for H.I.D. Lamps: are to be the manufacturer's best (quietest) sound rating, with the rating clearly indicated on the ballast case. Ballasts found by the Engineer to be unduly noisy shall be replaced without charge prior to acceptance of the job.

(e) Electronic Metal Halide Ballasts: electronic ballasts are to be used for metal halide lamps up to 150 W rating. Electronic metal halide ballasts are to provide “square wave” output at less than 200 Hz with no more than ± 0.5% variation in output power at ± 10% variation in input line voltage of 220V/ 60 Hz. Electronic metal halide ballasts are to have a minimum power factor of 95% and THD of less than 10%. Acceptable remote mounting distance is to be not less than 3.66 meters. Electronic metal halide ballasts are to have a “turnoff” safety function in event of failed or malfunctioning lamps or other abnormal conditions.

(f) Remote Ballasts for H.I.D. Lamps: are to be furnished in rated enclosures ready for mounting and connection. Enclosures, with more than one ballast, are to be furnished pre-wired. Provide acoustically isolated mounts for remote ballasts and ballast enclosures to assure quiet operation.
12  EMERGENCY LIGHTING

12.1  GENERAL

12.1.1  Scope

1  This part specifies the general requirements for emergency lighting and accessories both maintained and non-maintained. It shall be read in conjunction with other parts of the specifications and the project drawings.

2  Related Parts and sections are as follows:

- This section
- Part 1: General Provisions for Electrical Installations
- Part 10: Wiring Accessories and General Power
- Part 11: Light Fittings

12.1.2  Reference Standards

1  The following standards and documents are referred to in this part, and shall be complied with:

- BSEN50171: Central power supply system
- BSEN60529: Degrees of protection provided by enclosures (IP Code)
- ISO 9000: Quality management and assurance standards
- QGEWC: Qatar General Electricity & Water Corporation

12.1.3  Quality Assurance

1  The supplier’s manufacturing facility shall be certified to ISO 9000 or equivalent.

12.1.4  Warranty

1  Battery units, luminaires and accessories shall be warranted for a minimum of 5 years by the manufacturer. The battery shall have minimum 10 years useful life.

12.2  PRODUCTS

12.2.1  System

1  Emergency lighting installations shall be complete with emergency batteries, chargers, inverters, distribution boards, wiring, communication requirements, etc. all as described in specifications and as indicated on the Project Drawings, complying with BSEN 50171, ICEL 1009, etc.

2  Maintained and non-maintained luminaires shall be supplied directly from the battery system.
3 System shall be capable of supplying maintained luminaires directly without passing through the inverter. During utility power availability, system shall also ensure charging of batteries. At power failure, system is to directly supply the non-maintained fixtures while maintaining the supply of maintained luminaires and ensure power for 3 hours to illuminate emergency luminaires throughout the building.

4 System shall provide full addressable monitoring of the complete emergency lighting system. System must be capable of monitoring fluorescent, halogen, LED and other type of luminaires.

5 System should use approved software to schedule the automatic regular testing of emergency lighting system components. Software and test reports must be accessible remotely via LAN internet connection. The system must be capable of exporting data to BMS in specified format.

6 Interfaces and luminaires modules are to be provided as required by the manufacturer. Contractor is to provide a complete system with all components and accessories, even those not mentioned herein but required for the good function of the installation.

7 System must offer test input nodes which allow the Engineer to access test reports and control the system via a laptop from any point on the data cable.

12.2.2 central inverter system

1 General
   (a) System shall be capable of operating under temperatures ranging between 0°C and 50°C.
   (b) System shall be installed inside 2.0mm steel cabinets. Construction must be modular without welds and provided with leveling feet.
   (c) Degree of protection IP21.
   (d) Front access is only required with key lockable doors.
   (e) Ventilation to be provided in rear and front sides in order to allow cubicles to be mounted adjacent to each others.

2 System should be modular and offer at least the following features:
   (a) AC/AC - 50 Hz output
   (b) Ability to use standard AC distribution and protection devices (MCB) on outgoing circuits.
   (c) Overload capability in emergency mode: 200% in 10 sec. without reduction in output voltage.
   (d) Recharge capability: 80% after 12 hours following rated discharge.
   (e) Individual protection for each module using breakers.
   (f) Individual cooling fans for all modules and running on-demand.
   (g) Integral maintenance bypass facility
   (h) Split parallel temperature compensated charger.
(i) Comprehensive display
(j) Momentary “push to test” button.
(k) Alarm pack for charger and inverter.
(l) Local / remote maintained circuit control
(m) Battery earth leakage detection
(n) Interface with fire alarm system
(o) Sets of volt-free alarm relay contacts
(p) Comprehensive display
(q) Remote alarm unit
(r) Inverter-inhibit switch
(s) LED indications for
   (i) Mains health
   (ii) Maintained circuit on
   (iii) Battery high volt / low volt
   (iv) Supply from battery
   (v) Charge fail
   (vi) System fault
   (vii) Common alarm
   (viii) Battery discharged
   (ix) System inhibited
(t) Connection to BMS for points (i), (iv), (vi) & (viii)
(u) Sets of voltage free contacts alarm outputs as well as mutable local audible alarm.
(v) Protection against transient over voltages

3 Inverter Module:

Inverter module shall have at least the following characteristics:

(a) Nominal output: 240V, 50Hz AC
(b) Overload:
   (i) 120% continuous for 1 minute with full output
   (ii) 150% for 1 minute with full output
   (iii) 200% for 10 seconds with full output.
(c) Short circuit: 350% for 10 seconds.
(d) Cooling via integral fan (operation on-demand)
(e) Protection ensured with properly sized breakers

4 Charger module:
Charger module shall have at least the following characteristics:

(a) Constant voltage current limited with temperature compensation
(b) Voltage control to + 1% with full mains supply variations
(c) Cooling via integral fan (operation on-demand)
(d) Protection ensured with properly sized breakers.

5 Batteries

(a) Batteries shall be maintenance free, sealed lead acid, gas recombination type with a minimum design life of 10 years.
(b) Batteries shall have extremely low gas generation, low self-discharge and have permanently sealed pressure release vents.
(c) Batteries shall be sized to power the complete system for the rated duration following mains failure at 100% light out of all emergency lamps.
(d) Batteries shall be located inside system cabinet. Batteries located outside system cabinet are not accepted.

6 Cables

(a) Cables supplying all luminaires shall be of the approved fire resistant type.

12.3 INSTALLATION

12.3.1 wiring

1 The Contractor shall pay careful attention to cable routings so as to keep cable runs to the shortest possible length and ensure the overall volt drop on any circuit is within the tolerances of the luminaires connected and within the limits specified in the QGEWC regulations.

12.3.2 Installation of Batteries

1 The manufacturer’s recommendations/instructions shall always be followed.
2 Insulated tools shall be used.
3 Personnel erecting battery banks shall remove their personal metallic objects.
4 Eye and hand protection shall be provided.
5 Batteries shall not be left on site for prolonged periods without being trickle charged to maintain their condition i.e. if delivery is some weeks before commissioning of the charger.

12.3.3 Luminaires and Lamps

1 Luminaires and lamp installation shall comply with the requirements stipulated in Part 11 for general light fittings.
14. STRUCTURED CABLEING NETWORK

The provision of QCS Part 14 of Section 21 is considered deleted and replaced by the following requirements.

14.1 GENERAL

14.1.1 Related Documents

1 Contract
   (a) Drawings and general provisions of the Contract, including Conditions of Contract and Specification Sections, apply to this Section.
   (b) In particular, refer to these documents for all elements related to costs and responsibility related to delivery, storage, and roll-out phase.

14.1.2 Definitions

1 EMI: Electromagnetic Interference.
3 IP: Internet Protocol.
5 LAN: Local Area Network.
6 MTTR: Mean Time To Repair
8 QoS: Quality of Service.
9 SCN: Structured Cabling Network.
11 STP: Shielded Twisted Pair (some refer to this item as FTP: Foil-shielded Twisted Pair).
12 UL: Underwriters Laboratories.
13 UTP: Unshielded Twisted Pair.
14 WAN: Wide Area Network.

** Employer throughout the specifications refers to Public Works Authority (PWA).

** Operator throughout the specifications refers to Primary Health Care
14.1.3 Summary

1 This Section describes the Structured Cabling Network required to be implemented in the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor such as wires, cables, connecting devices, installation, and testing of the systems to be used as signal pathways for voice, data, and video transmission.

2 Scope of work consists of the installation of a generic structured wiring system based upon a star topology to connect all manner of applications covering voice, data, and video transmission, complying with the service provider specifications, including, but not limited to, the following:

(a) Coordination with service provider for work description and design demarcations. Design modifications are to be introduced by the Contractor.

(b) All service provider requirements, Contractor to ensure full in-service system compliant with provider requirements, ready for subscription,

(c) Voice, data and video outlets,

(d) Backbone cabling,

(e) Horizontal cabling,

(f) Equipment cabinets and racks, patch panels, F.O. cable termination drawers, cable trays, etc.

(g) Necessary conduits and raceways, patch cables, jumpers and ancillary equipment.

3 25% spare capacity is required at all levels of the system.

14.1.4 System Description

1 Scope of Works

(a) The Scope of Works shall include, but not limited to, detailed engineering, coordination, manufacture, supply, transportation, delivery, installation, testing, commissioning, setting to work, training and maintenance services during the 24-month Warranty Period for the Structured Cabling Network of the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor. This shall include at least the following tasks:

(i) Coordination with the Employer's, existing operators, contractors, and providers of interfaced systems,

(ii) Project management,

(iii) Planning management,

(iv) Finalization of system to the approval of the Employer,

(v) Supply of needed Structured Cabling Network equipment and components,

(vi) Transport, unloading, and storage on the site of the required equipment and components,

(vii) Equipment installation,
(viii) System installation and configuration,
(ix) System integration with interfaced and existing systems (if any),
(x) Complete testing of the system (unit tests, integration tests, final acceptance tests, users’ tests, etc.),
(xi) Training,
(xii) System implementation in the Employer's premises,
(xiii) System roll-out,
(xiv) System maintenance after successful initial proving period during Warranty,
(xv) Supply of spare parts for 2 years,
(xvi) System maintenance tools delivery,
(xvii) Writing and delivering of documentation (user’s manual, maintenance manual, test reports, etc.),

(b) This Section specifies the needs for the Structured Cabling Network and associated services to be purchased. The Structured Cabling Network represents passive components required to operate the overall IT network of the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor. It provides interfaces with other systems, and with other dedicated or existing networks as applicable.

(c) This Section specifies the furnishing, installing, certification, testing, and guarantee of a complete and operating Structured Cabling Network in the Health Centers at Al Wakra, Al Mashaf, Umm Snim, Al Khor and Al Shamal. The Contractor shall submit detailed schematic with appropriate matrix explaining all cable runs associated with various systems, to the approval of the Employer’s Representative. Type of cable specified is the minimum requirements envisaged, but it is the responsibility of the Contractor to provide the type (e.g. MM/SM) as required to meet the requirements of the associated systems.

(d) Technical specifications and architecture principles are generic and can be used to future extensions.

(e) This Section includes equipment for Structured Cabling Network (SCN) including, but not limited to, the following:
(i) Backbone Cabling subsystem:
   1) Direct fiber optic cable shall be provided from every IDF Horizontal Cross Connect (HCC) to the building Main Cross Connect (MCC) location in the main IDF Room at the ground level.
(ii) Horizontal Cabling subsystem:
   1) Cat 6A F/UTP shall be used for all horizontal cabling.
(iii) Cabinets,
(iv) 19” panels and racks,
(v) Optical fiber panels,
(vi) RJ45 patch panels:
1) Horizontal cables shall be terminated in high density Cat 6A patch panels.

(vii) Wire guide,
(viii) Optical fiber cables,
(ix) Foil/Unscreened Twisted Pair (UTP) cables,
(x) Optical connectors,
(xi) RJ45 connectors,
(xii) Patch cords,
(xiii) CAT3 Analogue Telephone Cables,
(xiv) RJ11 connectors,
(xv) XC110 IDF CAT3
(xvi) XC110 MDF CAT3
(xvii) Cable trays,
(xviii) Outlet box and frame,
(xix) Conduits and tubes,
(xx) Earthling and grounding.

(f) Cabling Philosophy:
(i) Cat 6A cable shall be used for all RJ 45 connections.
(ii) Direct copper lines shall be provided as per Client’s requirements for redundancy at locations shown on the drawings.

(g) IDF Horizontal Cross Connect Rooms (HCC):
(i) Cabinets:
1) Adequately sized cabinets shall be provided for all horizontal cables in each IDF (HCC) room for copper links, fiber optic links, and active communication and data processing equipment.

(ii) Patch Panels and Accessories:
1) Provide copper patch panels and accessories for data, voice and for all other systems to be connected in the technical room.
2) Provide fiber patch panels, patch cords, and accessories for termination of cables for data and all other systems.

(h) Main Cross Connect (MCC) in Main IDF Room (ground level):
(i) Cabinets:
1) Adequately sized cabinets shall be provided for all backbone cables coming from the floor IDF (HCC) rooms for fiber optic links, and active communication and data processing equipment.
2) Dedicated and adequately sized cabinets shall be provided for all cables coming from the global campus network and for all active communication and data processing equipment.

(ii) Patch Panels and Accessories:
1) Provide fiber patch panels, patch cords, and accessories for termination of cables for data and all other systems.

2) Provide fiber patch panels, patch cords, and accessories for data and all other dedicated networks to be connected to the global campus network or to dedicated systems.

(iii) It shall be the responsibility of the Contractor to ensure minimum 50% spare on all fiber optic cable links. Special care shall be taken in technical rooms with more than two stacks, to take care of the additional uplink requirements.

(iv) All technical rooms shall have Class “A” fiber links.

(v) This document also includes the recommendations and necessary coordination with power distribution in relation with the cabling system.

(vi) Labeling scheme for outlets, patch panels, cables, junction boxes, cabinets, etc. shall be unique and informative.

2 Coordination

(a) Coordinate Works of this Section with the Employer’s:

(i) Departments, operators, contractors, organization, etc.

(ii) Construction and implementation works.

(iii) Active communication and data processing equipment.

(iv) Workstations and servers suppliers.

(v) IT systems providers using the Structured Cabling Network.

(vi) Others (list given above not exhaustive).

(b) Coordinate with Ooredoo to confirm location of services’ entrance arrangement into the premises. The Contractor shall liaise with Ooredoo to obtain design approval, equipment and ensure connectivity.

(c) Meet jointly with representatives of above concerned organizations, contractors, and Employer’s Representative to exchange information and agree on details of project implementation, transition plan, equipment arrangements and installation interfaces, etc.

(d) Record agreements reached in meetings and distribute record to other participants.

(e) Adjust arrangements and locations of equipment in technical rooms and way of wiring closets to accommodate and optimize arrangement and space requirements.

3 Variant and Options

(a) The Contractor should propose no variant.

(b) Options consisting in additional provisions to the basic system may be submitted to the Employer for approval, with specifications, characteristics, aiming and full particulars of calculations and equipment selections. All options shall be priced separately.
14.1.5 Submittals

1 Design Submission

(a) Shall include, but not limited to:

(i) Equipment and material datasheets must include (at least) the following information:
   1) Product performance and existing features,
   2) Features, ratings, and performance for each component specified,
   3) Standardized tests passed and results and available product certificates,
   4) Product compatibility matrix with other manufacturers/vendors.

(b) System Requirement and Design Specification

(i) System Architecture and justification.

(ii) Justification of performance requirements.

(c) Technical documentation and troubleshooting guides shall be provided in English, both paper and electronic version, for each type of component in the offer.

(d) Product Certificates: signed by Manufacturers certifying that products furnished comply with requirements.

(e) Test Plan:

(i) The Contractor shall provide Test Plan on the testing methodologies used for various tests involved throughout different stages of the Works. This shall also include the plan for integrated tests for interface with other systems. The Contractor shall submit the Test Plan for approval by the Employer’s Representative.

(ii) Test program shall be part of the test plan.

(iii) In establishing the test program, the Contractor and the Employer’s Representative shall agree which activities shall be attended by the Employer’s Representative.

(iv) After approval, the Test Plan shall be amended as required during the life of the Project to reflect changes in system design and the identification of additional testing requirements.

2 Project Schedule

(a) Provide a detailed Build Plan that includes, but is not limited to:

(i) All activities required to deliver a production ready network to the Employer.
   1) The duration of each activity in days,
   2) The resources required to complete each activity,
   3) Any dependencies amongst activities.

3 Product Data
(a) Include detailed Manufacturer's specifications and data sheets for each system component.

(b) Include data on features, ratings, and performance for each component specified.

(c) For each type of equipment and material, submit data for approval including catalogues and literature, sufficiently detailed for engineering purposes, and with full description of components and operating parameters.

(d) Description must cover this specific Project; Manufacturer's standard descriptions for generic systems are not acceptable.

4 Shop Drawings

(a) Indicate layout, wiring diagrams including typical details and dimensions.

(b) Locate devices and components on drawings.

(c) Submit drawings for approval including, but not limited to, the following:
   (i) Detailed system schematic diagram,
   (ii) Layout of network components,
   (iii) System labeling schedules, including electronic copy of labeling schedules in software and format selected by the Employer's Representative.

(d) Complete electrical and physical characteristics of network components.

(e) Complete system wiring diagrams, size and type of cables, enclosures, and terminal, splice boxes etc., and routing plans of wiring system.

(f) Include dimensioned plan and elevation views of components. Show access and workspace requirements.

5 Manufacturer's Installation Instructions

(a) Provide Manufacturer's installation instructions.

(b) Certificates signed by Manufacturers of equipment certifying that the provided products comply with contract specified requirements.

6 Product Certificates

(a) The Contractor shall provide certificates signed by Manufacturers of components certifying that the provided products comply with requirements.

7 Qualification Data

(a) For firms and persons specified in "Quality Assurance" an article shall be written to explain and demonstrate their capabilities and experience.

(b) To include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by the Employer's Representative.

(c) An experienced Contractor, which is an authorized representative of the Manufacturer, for both installation and maintenance purpose, is formally required for this Section.
8 Tests and Certificates

(a) Test Specifications as defined in the Test Plan shall be submitted for Approval.

(b) Submit complete certified Manufacturer's type and routine test records, in accordance with the Standards specified in "Quality Assurance" Article.

(c) It shall specify test results for compliance with performance contract requirements.

(d) Include record of signal ground resistance measurement certified by the Contractor.

9 Field Test Reports

(a) As specified in "On-Site Tests and Inspections" Article of this Section, the Contractor shall indicate and interpret test results for compliance with system description and performance requirements.

10 Record (As-Built) Drawings

(a) Complete wiring diagrams, including complete terminal strip layout and identification, and wire termination and tagging for all conductors.

(b) Locations for all components installed and/or connected to under this Specification.

11 Sample Warranty

(a) Copy of Manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.

(b) Provide copy of sub-contractor's warranty certificates.

(c) Provide Contractor's warranty certificates.

12 Maintenance Data

(a) For products and systems, the Contractor shall include maintenance manuals.

(b) The Contractor shall include data for each type of product, including all features.

(c) The Contractor shall include recommendations for spare parts and components to be stocked at Project site.

13 Test Equipment List

(a) The Contractor is responsible for furnishing all test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system. The Contractor shall furnish test equipment of accuracy better than the parameters to be tested. The test equipment furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test.
14.1.6 Regulations And Standards

1 Rules

(a) The Works shall be conformed to requirements of referenced industry standards, applicable Sections.

(b) The Works shall be compliant with Local Requirements, applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Employer’s Representative, in writing.

(c) Conflict: Should an instance occur in this Specification and referenced Sections in which equipment, components, material or construction methods called for is less than minimum requirement of the referenced industry standards, rules, local regulation, etc., the Employer’s Representative shall be immediately informed in writing. Consequent to the Employer’s Representative’s approval, supply the equipment, components, material and perform the work as through called for to minimum code standards.

2 Standards

(a) Standards to be used is the IEC or other equal and approved codes, taking into account that network cables with fitted accessories and connector and wiring have to be of fire rated type in accordance with all NFPA requirements codes (NFPA72 and extensions).

(b) System components, parts, and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC).

(i) ISO/IEC 11801: latest edition regarding Information Technology and generic cabling for customer premise.

(ii) EIA/TIA 568, Commercial Building for Telecommunication Wiring Standard.

(iii) EIA/TIA 569, Commercial Building for Telecommunication Pathways and spaces.

(iv) EIA/TIA 606 for Telecommunications Infrastructure: this document provides the user with guidelines and choices of classes of administration for maintaining telecommunications infrastructure.


(vi) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.

(vii) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.

(viii) IEC 60331 part 11 & 12, Tests for Electric Cables under Fire Conditions.

(ix) IEC 60332 Tests on Electric Cables under Fire Conditions.

(x) IEC 60364-1 Electrical Installations of Buildings, Fundamental
Principles, Assessment of General Characteristics, Definitions.

(c) Comply with the latest issue of several material and test standards, which have been developed and published by Institute of Electrical and Electronics Engineers (IEEE) for data communications industry, but not limited to:

(i) 802.1 – Network Management Group,
(ii) 802.2 – Logical Link Control Group,
(iii) 802.3 – Carrier Sense Multiple Access/Collision Detection Group,
(iv) 802.6 – Metropolitan Area Networking Group,
(v) 802.7 – Broadband Technical Advisory Group,
(vi) 802.8 – Optic Fiber Technical Advisory Group,
(vii) 802.9 – Integrated Voice and Data LAN Working Group,
(viii) 802.10 – LAN Security Working Group,
(ix) 802.11 – Wireless Networks
(x) 802.12 – Fast Ethernet.

(d) Comply, as often as possible, with both ITU-T (International Telecommunications Union) recommendations and US standards. When standards are not compatible in both Europe and US (e.g. telecom interfaces SDH STMx vs. SONET OCx) detailed compatibility and interface availability shall be provided.

(e) Building Industry Consulting Service International (BICSI):

(i) Publishes the Telecommunications Distribution Methods Manuel (TDM).

(f) Comply with the latest issue of several material and test standards, which have been developed and published by Network Equipment Building System (NEBS). Level 1, Level 2, and Level 3 are applicable to this Section:

(i) SR3580: NEBS: Criteria Levels.
(ii) GR-63-Core: NEBS: Physical Protection.
(iii) GR-1089-Core: NEBS: EMC and Safety.
(iv) European Telecommunications Standards Institute (ETSI).

(g) Safety:

(i) UL 1950, 3rd edition.
(ii) EN 60950/IEC60950.
(iii) EN60825 Laser Safety (Class 1).

(h) EMI:

(i) FCC part 15 Class A, B.
(ii) EN55022 Class A, B.

(i) Immunity:

(i) EN-61000-4-2 ESD.
(ii) EN-61000-4-3 Radiated Immunity.
(iii) EN-61000-4-4 EFT.
(iv) EN-61000-4-5 Surge.
(v) EN-61000-4-6 Low-Frequency Common Immunity.
(vi) EN-61000-4-11 Voltage Dips and Sags.
(vii) EN-61000-3-2 Power-Line Harmonics.

3 Precautions

(a) The above list is a partial list issued from standard organizations. Additional consideration may be required to provide protection of communication equipment and materials and protection of data from intrusion, induced noise or other events that can disrupt vital operation.

14.1.7 Quality Assurance

1 Requirements

(a) All Works shall be executed and controlled by a quality management system in accordance with the requirements of ISO 9001.
(b) This system shall comprise all the participants to the Contract within the Contractor's teams and its sub-contractors.
(c) The Quality Assurance Plan shall be based on quality manuals of the Contractor and sub-contractors.
(d) The Contractor shall nominate from the beginning of the Project, the person in charge of quality assurance of the whole project, who is directly linked to the Project Director.
(e) The Contractor should establish from the beginning of the Project, the Quality Assurance Plan based on Contractor's quality system that should define:
   (i) Scope of Quality Assurance Plan, with conditions of validity and revision,
   (ii) Approach and structure of the Contractor's quality management system to fulfill the requirements of the Contract and ISO 9001,
   (iii) Organization retained for the Project with sub-contractors list,
   (iv) Details of how the Contractor proposes to manage sub-contractors and to ensure that the relevant quality system requirements of ISO 9001/2 are observed and implemented by the sub-contractors in the execution of the works sub-contracted,
   (v) The quality plans of the Contractor.

2 Manufacturer Qualifications

(a) A firm specializing in providing Structured Cabling Network components and materials similar to that indicated for this Project and with a record of successful in-service performance.
(b) Manufacturer's systems shall be, as often as possible, a standard "off-the-
shelf" package utilizing the latest hardware technology. Any major system development effort necessary to meet specified requirements is unacceptable. Even if this system is a new concept, it should not require huge development and shall be based on existing and proven technologies.

(c) Manufacturer or factory-authorized agency shall maintain a service center capable of providing training, parts, and emergency maintenance and repairs for overall system at Project site with eight hours of maximum response time.

3 Installer Qualifications

(a) An experienced Installer who is an authorized representative of the equipment Manufacturer for both installation and maintenance of Manufacturer's equipment, and who has completed system installations similar in design and extent to that indicated for this Project, with a record of successful in-service performance.

4 Materials and Workmanship

(a) They shall conform to the latest issue of all industry standards, publications, or regulations referenced in this Section, including the following, as applicable:

(i) Regulations and Standards: System components, parts, and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC).

(ii) Compliance with Local Requirements: Comply with applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Employer's Representative, in writing.

(iii) Conform to requirements of referenced industry standards, applicable Sections.

5 Source Limitations

(a) For each category of technology used for the Structured Cabling Network, obtain system components from one Manufacturer who shall assume responsibility for the system components and for their compatibility.

14.1.8 Coordination

1 Coordinate with the Employer's Representative to confirm location of equipment, devices and system components.

2 Meet jointly with representatives of concerned organizations, operators, contractors, and Employer’s Representative to exchange information and agree on details of project implementation, transition plan, equipment arrangements and installation interfaces, etc.

3 Record agreements reached in meetings and distribute record to other participants.
14.1.9 Testing And Reports

1 The Contractor shall test all components and circuits of the Structured Cabling Network after installation to ensure functionality and performance within industry approved guidelines.

2 A written report shall be submitted describing testing procedure and detailing test results.

3 The Contractor shall provide and supply all necessary technical and skilled manpower, tools, test equipment, materials and transportation required for performing system and components testing.

14.1.10 Record Documentation

1 Operation and Maintenance Manuals
   (a) The Contractor shall submit full system documentation for the installed system and all ancillary equipment.
   (b) System documentation shall consist of:
      (i) A complete set of product data for all component and parts.
      (ii) A complete set of operations manuals for all components of the system.
      (iii) Maintenance manuals for all components of the system and for the system as a whole.

2 Test procedure, data and results from acceptance testing.

14.1.11 Warranty

1 Special Warranty
   (a) Manufacturer’s Warranty: Provide written warranty, signed by the Manufacturer and the Installer agreeing to replace system devices and that fail in materials or workmanship within specified warranty period.

2 Initial Experimental Period
   (a) There shall be an experimental period of 90 days after successful testing and commissioning of the system, but before issuance of substantial completion certificate. During this period, the Contractor shall undertake supervision and responsibility for operation of the system under actual site conditions. If any malfunctioning or anomaly noted on the system during this period, it shall be attended immediately. The experimental period will restart automatically from the date of clearing such troubles and start normal operation.
   (b) During this period, the Contractor shall fully demonstrate the system performance under actual operation conditions. This demonstration is to confirm, to the satisfaction of the Employer’s Representative, that the system is free of remarks and is ready for provisional taking over.
   (c) After the satisfactory completion of this period, the system is to be taken over by the Employer, as per Contract Conditions, whereby the Warranty
3 Warranty Period

(a) Two years from the satisfactory completion of the Experimental Period.

(b) During the Warranty Period, the Contractor shall undertake Maintenance actions as defined in the Maintenance and Warranty Article.

(c) During the Warranty Period, the Contractor shall provide, at its own cost, all required spare parts needed to replace existing components unless it is proved that the component to be replaced was damaged by abuse.

4 Manufacturer Product Performance

(a) The Contractor shall provide a Manufacturer endorsed and backed extended 20-years product, performance, application, and labor warranty which shall:

   (i) Warrant against defects in materials and workmanship (extended product warranty) for a period of 10 years.

   (ii) Warrant that all cabling components of the installed system will meet or exceed the specifications of TIA/EIA 568C and ISO/IEC IS 11801 (performance warranty) for a period of 20 years.

   (iii) Warrant that all unshielded/shielded twisted pair cabling links/channels will meet or exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of 20 years.

   (iv) Warrant that all fiber links/channels shall meet or exceed the loss and bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of 20 years.

   (v) Warrant that the system shall be application independent and shall support both current and future applications that use the TIA/EIA 568C or ISO/IEC 11801 component and link/channel specifications for cabling (application warranty), for a period of 20 years.

   (vi) Warrant that all labor attributable to and required by the above shall be supplied at no cost to the Owner for a period of 10 years.

14.1.12 Commissioning

1 During this phase the equipment are powered and the automation and networking are gradually integrated layer by layer.

2 The tests shall be performed by the Contractor and witnessed by the Employer's Representative.

3 Any defects, which may become apparent during the course of these tests, shall be immediately rectified by the Contractor at his expense.

4 The Site Acceptance Test Specifications shall be prepared by the Contractor and submitted for Approval.

5 All Site Acceptance Tests shall be carried out in the presence of the Employer's representative who shall sign off the testing documentation on satisfactory
 completion of the tests.

6 The results of the Site Acceptance Tests, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer's Representative.

14.1.13 Maintenance

1 Maintenance Service

(a) During the Warranty Period, Manufacturer or factory-authorized agency shall maintain a service center capable of providing spare parts and emergency maintenance and repairs for the overall system at Project site 7 days a week and 24 hours a day. Competent personnel shall be dispatched to rectify stoppages at any time during the day or night when being called on by the Employer.

(b) The Contractor shall submit a Service-Call Report to be sent to the Employer immediately following every call out, indicating the time of call out visit, cause, remedial action taken and the time that the service was restored.

(c) A Maintenance Manpower Plan shall demonstrate the Contractor’s committed resource level available for all types of activities to be carried out within the Warranty Period. Such plan shall be submitted for Approval six months before commencement of the Warranty Period.

(d) The Contractor’s response time, during the Warranty Period, shall not exceed 1 hour. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at where the faulty equipment is located.

(e) During the Warranty Period, the MTTR shall not exceed 30 minutes. The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing time on site, but shall exclude the response time.

(f) During the Warranty Period, the monthly average of the Repair Time shall be lower or equal to six minutes for each device. This performance will be checked.

(g) The Contractor shall liaise with the Employer’s Representative and carry out safety and performance inspections for the installation on site. Any necessary adjustments to the installation shall be made within 14 days of completion of such checks. A Safety and Quality Report shall be submitted, no later than 14 Days after such safety and performance checks, for the Employer’s Representative’s approval.

(h) The Contractor shall provide at least four inspection visits at six-month interval during the Warranty Period.

(i) The Contractor shall be responsible to clear away from the Site all surplus materials, rubbish, temporary works of every kind and leave the whole of the Site and installation clean and in a workmanlike condition to the satisfaction of the Employer’s Representative, upon completion of each item of the repair, and maintenance works.
14.1.14 Global System Requirements

1 General

(a) Cables shall enter the equipment racks or enclosures in such a manner that all doors or access panels shall open and close without disturbing or damaging the cables. All cables shall be installed in conduit, ducts, conduit or trays in accordance with NEC art.517 and 800. Coordinate the features of material and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

14.1.15 Spare Parts And Extra Material

1 Extra Materials

(a) The Contractor shall provide extra material that match products installed and that are packaged with protective covering for storage and identified with labels clearly describing contents to ensure the operation of the Structured Cabling Network.

2 Spare Parts

(a) The Contractor shall provide Manufacturer recommended spare parts for all major components in the system for two years fault free operation.

(b) However, a minimum of 2% peripherals of each type installed, but not less than one from each type shall be included in the deliverable irrespective of Manufacturer recommendation.

(c) During the Warranty Period, the Contractor shall provide, at his cost, all required spare parts needed to replace existing components unless it is proved that the component to be replaced was damaged by abuse.

(d) The Contractor shall guarantee the flow and availability of the spare parts without a major design change for at least ten years period.

14.2 PRODUCTS

14.2.1 General

1 This Section describes the minimum requirements for the Structured Cabling Network.

2 All hardware must be a current offering of the Manufacturer, and be receiving the highest level of support offered by the Manufacturer.

3 All hardware shall be new equipment.

4 The purpose of the Structured Cabling Network is to realize a common cabling infrastructure able to connect any type of equipment such as voice, data and video terminals.

5 In order to achieve this purpose and to perpetuate as much as possible the present investments, the cabling system shall be of:

6 Routing Type: Each room shall be equipped with one or several connecting...
access points according to their use and surface area on one end and the terminals to be installed on the other end.

7 **Standardized Type:** All sockets of each connecting access points shall have the same technical characteristics and shall be equipped with the same number of pairs.

8 **ISO Code Type:** Cabling system shall comply with the international ISO 11801 codes. In addition, cabling system shall comply with the performances of the active communication and data processing network, twisted pairs type or fiber optic type.

### 14.2.2 Architecture Of The Structured Cabling Network

1 The architecture of the cabling system shall be sufficiently flexible in order to allow any input reconfiguration at the distribution level.

2 Network architecture shall be based on the following parts:
   
   (a) Building Core/Distribution Node.
   (b) Floor Distribution Node.
   (c) Horizontal Cabling Network.
   (d) Backbone Cabling Network.

3 Distribution panels shall include one or several cabinets or group of panels to be installed in technical rooms.

### 14.2.3 Equipment Cabinets

1 **19 inch Cabinets**

   (a) All cabinets shall be free standing standard universal 19 inch wide racks except for distribution nodes of small capacity, which may be of wall mounted 19 inch racks.

   (b) 19-inch cabinets shall be provided with the following equipment:
      
      (i) A pair of 19 inch front uprights set back 100 mm from front face.
      (ii) 42U 800 x 800 mm structure.
      (iii) Twin vertical cable management system for front side of the rack, extending to the full height of the rack including trim plates.
      (iv) Removable and lockable side panels.
      (v) Double glazed lockable front 400 mm doors.
      (vi) Double plain lockable rear 400 mm doors.
      (vii) Roof blanking plate with ventilation and 300 x 50 mm cable hole as a minimum.
      (viii) A pair of 300 mm basket trays for cable fixing.
      (ix) Earth bus bar.

   (c) Cabinets installed on raised floor shall be fitted with leveling feet.
(d) Cabinets installed on slab shall be fitted with 100 mm height base with 300 x 50 mm cable hole.

2 Wall Mounted Racks

(a) 19 inch wall mounted racks shall be provided with the following equipment:
   (i) A pair of 19 inch front uprights set back 100 mm from front face.
   (ii) 9 to 21U 600 x 600 mm structure depending on needs.
   (iii) Fixed 150 mm backboard and removable enclosure.
   (iv) Dual locking hinge.
   (v) Twin vertical cable management system for front side of the rack, extending to the full height of the rack.
   (vi) Single glazed lockable front door.
   (vii) Wall brackets.
   (viii) Cable doors, 250 x 50 mm sized on top and bottom and back panel.
   (ix) 250 mm basket tray for cable fixing.
   (x) 19 inch power strip, flush mounted outlets with RCD and pilot lamp for rack used for both cabling and active parts.
   (xi) Earth bar.

3 Common Equipment to Cabinets and Racks

(a) Multi-formed mounting channels shall be standard gauge cold rolled steel, with secondary chassis providing infinite front-to-back adjustment.

(b) Base section shall be, as a minimum, 1.5 mm thick cold rolled steel. Blower panels shall be installed in base section of each cabinet to provide required filtered air at zero static pressure.

(c) Depth of unit is to allow cable access through bottom and back of racks.

(d) Finishes:
   (i) Steel cabinets and consoles shall be coat with phosphate or galvanized sheet steel box constructed with joints welded on inside and treated with one weatherproof base coat and two coats of epoxy paint or approved air-drying enamel of color to be selected by the Employer’s Representative.

(e) Any system unit shall be of 19 inch type and withdraw-able and hinge-racked type.

(f) Cabinets shall be of 19 inch frame, totally enclosed, with side and rear panels removable, and cable entrance at rear, top or bottom. Surface finish shall be textured and have approved color. Frames shall be anodized aluminum sections. Each frame shall be provided with ventilation rack, including automatically operated fan with thermostatic control. Suitable ventilation openings shall be provided. Enclosure shall be IP 42 to IEC 144 for indoor installation.

(g) Storage: racks and cabinets shall have storage drawers for cables and accessories.
(h) Mains Wiring: equipment shall operate from 240 V, 50 Hz mains and shall be capable of continuous operation under any load conditions with variations of +/-10% of nominal voltage. Mains wiring inside consoles shall be totally segregated from low level signal wiring.

(i) Electric connections, other than those for low level signals, shall be of push-on spade clips type or multi-connector blocks type.

(j) Low Level Signal Wiring: heavily braided, PE insulated, screened cable, PVC sheathed with standard DIN plug connections. Amplifier output lines shall be twisted pairs heavily screened and fire proof type. Hum-producing earth return loops shall be avoided.

(k) Equipment Racks
   (i) 19 inch rack shall be provided with the following equipment:
      1) Equipment cabinets shall comprise free standing 475 mm (19") racks inside enclosed cabinets.
      2) Standard holes shall be provided for panel mounting of control equipment and cable distribution terminal boards, which shall be easily accessible for maintenance.

4 Optical Fiber Drawer

(a) The Contractor shall provide 1U, 12/24/36 LC duplex optical fiber drawers for multi- and single- mode fiber optic cables for both vertical and horizontal distribution.

(b) Optical fiber drawer shall consist of:
   (i) 19-inch rack-able set,
   (ii) 1U height enclosure,
   (iii) Loop module,
   (iv) Cable back entries including bushing,
   (v) Adjustable fixing devices,
   (vi) Adjustable front panel,
   (vii) 12/24/36 LC duplex ports,
   (viii) Label holder.

(c) All ports receiving fiber optic cable shall be fitted with LC duplex connectors.

(d) All spare/unused ports shall be fitted with LC duplex cover.

5 RJ45 Patch Panels

(a) RJ45 patch panels dedicated for RJ45 horizontal and vertical twisted pairs wiring shall be installed in 19 inch racks dedicated to RJ45 jacks.

(b) RJ45 patch panels shall consist of:
   (i) 19-inch rack-able set,
   (ii) 1U height 24 ports or 1U/2U height 48 ports,
   (iii) Cable holder back plate,
(iv) Front panel with individual shutter for each port,
(v) Label holder for each port,
(vi) Label holder for patch panel,
(vii) Earthling kit.

6 Patch Cord Guide Panels

(a) Patch cord guide panels shall be installed in the racks to ensure cabling management.

(b) Patch cord guide panel shall consist of:
   (i) 19-inch rack-able set,
   (ii) 1U height,
   (iii) Front panel set back from rack framework to avoid door opening problems,
   (iv) 3 front open rings,
   (v) Storage elements for spare cable lengths on the rear.

7 XC110 IDF CAT3

(a) Intermediate distribution frames (IDF) shall be XC110 CAT3 types and shall be wall mounted installed in locations as indicated on the drawings.

(b) XC110 IDF shall be used as a horizontal cross connect (HCC) for all analog telephone outlets as indicated on the riser diagrams.

(c) XC110 IDF shall be consist of terminal Blocks of standard pair capacity (25pairs/5 pairs) which shall be installed and fixed in the intermediate distribution frames.

(d) Each terminal block shall bear clear marks for wire pairs.

(e) Connections shall be made by means of insulation displacement contact (IDC).

8 XC110 MDF CAT3

(a) Main distribution frame (MDF) shall be XC110 CAT3 termination blocks wiring for both of internal lines and trunk lines and it shall be wall mounted installed in locations as indicated on the drawings.

(b) MDF shall have protection modules which shall be installed on the trunk lines’ connectors.

(c) MDF shall have the possibility of tracing faults, testing of all connections and maintaining telephone network.

(d) MDF shall provide protection of lines from any overload or failure in the trunk or extension lines connected to other equipment or systems which may cause damage to the PABX.

(e) MDF shall be of modular design allowing for extension in blocks having all the mentioned features.

(f) The capacity of the MDF shall be as indicated on the drawings.

(g) MDF shall have the possibility of grouping and cross connecting the lines
for trouble shooting and maintaining of the wiring of the telephone network coming from different localities and directions.

(h) Extra earth wire shall be provided in the distribution network starting from the MDF to the last terminal box before the outlets.

14.2.4 Cables

1 Fiber Optic Cable

(a) The fiber optic cables shall be either multi-mode or single-mode depending of their function and shall meet or exceed TIA/EIA 568C specifications.

(b) Multi-mode, 50/125 microns fiber optic cables shall have the following minimum performance characteristics:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core diameter</td>
<td>50 ± 3 µm</td>
</tr>
<tr>
<td>Coating diameter</td>
<td>125 ± 2 µm</td>
</tr>
<tr>
<td>Muffling/reducing</td>
<td></td>
</tr>
<tr>
<td>$\lambda = 850$ nm</td>
<td>$\leq 3.0$ dB/Km</td>
</tr>
<tr>
<td>$\lambda = 1300$ nm</td>
<td>$\leq 1.0$ dB/Km</td>
</tr>
<tr>
<td>Bandwidth</td>
<td></td>
</tr>
<tr>
<td>$\lambda = 850$ nm</td>
<td>$\geq 500$ MHz.km</td>
</tr>
<tr>
<td>$\lambda = 1300$ nm</td>
<td>$\geq 500$ MHz.km</td>
</tr>
<tr>
<td>Support 1000 base SX</td>
<td>Up to 600 m</td>
</tr>
<tr>
<td>Support 1000 base LX</td>
<td>Up to 1200 m</td>
</tr>
</tbody>
</table>

(c) Single-mode, 9/125 microns fiber optic cables shall have the following minimum performance characteristics:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core diameter</td>
<td>9.2 ± 0.5 µm</td>
</tr>
<tr>
<td>Coating diameter</td>
<td>125 ± 2 µm</td>
</tr>
<tr>
<td>Muffling/reducing</td>
<td></td>
</tr>
<tr>
<td>$\lambda = 1310$ nm</td>
<td>$\leq 0.42$ dB/Km</td>
</tr>
<tr>
<td>$\lambda = 1550$ nm</td>
<td>$\leq 0.28$ dB/Km</td>
</tr>
<tr>
<td>Dispersion range</td>
<td></td>
</tr>
<tr>
<td>$\lambda = 1310$ nm</td>
<td>$\leq 3.5$ ps/nm.km</td>
</tr>
<tr>
<td>$\lambda = 1550$ nm</td>
<td>$\leq 18$ ps/nm.km</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Color</th>
<th>Fiber</th>
<th>Color</th>
<th>Fiber</th>
<th>Color</th>
<th>Fiber</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Blue</td>
<td>7</td>
<td>Red</td>
<td>13</td>
<td>Blue + 1 ring</td>
<td>19</td>
<td>Blue + 2 ring</td>
</tr>
<tr>
<td>2</td>
<td>Orange</td>
<td>8</td>
<td>Black</td>
<td>14</td>
<td>Orange + 1 ring</td>
<td>20</td>
<td>Orange + 2 ring</td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td>9</td>
<td>Yellow</td>
<td>15</td>
<td>Green + 1 ring</td>
<td>21</td>
<td>Green + 2 ring</td>
</tr>
<tr>
<td>4</td>
<td>Brown</td>
<td>10</td>
<td>Violet</td>
<td>16</td>
<td>Brown + 1 ring</td>
<td>22</td>
<td>Brown + 2 ring</td>
</tr>
<tr>
<td>5</td>
<td>Grey</td>
<td>11</td>
<td>Pink</td>
<td>17</td>
<td>Grey + 1 ring</td>
<td>23</td>
<td>Grey + 2 ring</td>
</tr>
</tbody>
</table>
2 Outdoor Fiber Optic Cable

(a) Fiber optic cables using external routing, e.g. between buildings, shall be single-mode cables only.

(b) These cables shall have the following characteristics:
   (i) Loose-tube type structure,
   (ii) Non-metallic armor,
   (iii) Longitudinal waterproofing of entire cable without gel,
   (iv) Glass fiber anti-rodent protection,
   (v) LSOH Polyethylene outer jacket,
   (vi) Metric marking indicating type of cable, year, ref., number,
   (vii) Secondary coating: 250 µm,
   (viii) Maximum pulling tension: 1700 N,
   (ix) External diameter: < 17 mm.
   (x) Installation temperature: -5°C / +50°C,
   (xi) Storage/transport temperature: -30°C / +70°C,
   (xii) Operating temperature: -20°C / +60°C,
   (xiii) Minimum bending radius:
          1) Static: 200 mm,
          2) Dynamic: 300 mm.
   (xiv) Crush resistance:
          1) Permanent: 50 N/mm,
          2) Instant: 80 N/mm.
   (xv) Maximum allowable flexing resistance: 40 daN,
   (xvi) Weight: 300 kg/km,
   (xvii) Complies with IEC 60754-1,
   (xviii) Complies with IEC 60754-2,
   (xix) Complies with IEC 60332-3C,
   (xx) Complies with IEC 61034,
   (xxi) Complies with IEC 60331.

3 Indoor Fiber Optic Cable

(a) Fiber optic cables installed within buildings, in conduits or trays, shall be as follows:
   (i) 24- Cores single-mode,
   (ii) 12- Cores single-mode,
(iii) 24- Cores multi-mode,
(iv) 12-Cores multi-mode,
(v) Other types as mentioned elsewhere in this document.

(b) Fiber optic cables used for vertical links shall have the following characteristics:
   (i) Mini-tube type structure,
   (ii) Cable reinforced with coated glass fiber,
   (iii) LSOH Polyethylene outer jacket,
   (iv) Metric marking indicating type of cable, year, ref., number,
   (v) Secondary coating: 250 µm,
   (vi) Maximum allowable tension: 1300 N,
   (vii) External diameter: 7 mm,
   (viii) Installation temperature: 0°C / +40°C,
   (ix) Storage/transport temperature: -20°C / +70°C,
   (x) Operating temperature: -10°C / +60°C,
   (xi) Minimum bending radius:
       1) Static: 100 mm,
       2) Dynamic: 140 mm.
   (xii) Crush resistance: 300 N/cm,
   (xiii) Weight: 55 kg/km,
   (xiv) Complies with IEC 60754-1,
   (xv) Complies with IEC 60332-3C.

(c) Fiber optic cables used for horizontal links shall have the following characteristics, or according to TIA/EIA:
   (i) Tight-buffer type structure,
   (ii) Cable reinforced with aramid fibers,
   (iii) LSOH Polyethylene outer jacket,
   (iv) Metric marking indicating type of cable, year, ref., number,
   (v) Secondary coating: 900 µm,
   (vi) Maximum allowable tension: 1000 N,
   (vii) External diameter: 6.5 mm,
   (viii) Installation temperature: 0°C / +40°C,
   (ix) Storage/transport temperature: -30°C / +70°C,
   (x) Operating temperature: -30°C / +60°C,
   (xi) Minimum bending radius:
       1) Static: 45 mm,
       2) Dynamic: 130 mm.
(xii) Crush resistance: 600 N/cm,

(xiii) Weight: 45 kg/km,

(xiv) Complies with IEC 60754-1,

(xv) Complies with IEC 60332-3C.

4 Twisted Pair Cables

(a) Cables used in this project shall comply, as a minimum requirement, with Cat 6A cable performance defined by standard TIA/EIA-568C

(b) Twisted pair cables performance shall meet the following values:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Attenuation (DB/100m)</th>
<th>NEXT (DB)</th>
<th>PSNEXT (DB)</th>
<th>ELFEXT (DB/100m)</th>
<th>PSELFEXT (DB/100m)</th>
<th>RL</th>
<th>Delay</th>
<th>PSANEXT</th>
<th>PSAACRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.1</td>
<td>74.3</td>
<td>72.3</td>
<td>67.8</td>
<td>64.8</td>
<td>20.0</td>
<td>570</td>
<td>67.0</td>
<td>67.0</td>
</tr>
<tr>
<td>4</td>
<td>3.8</td>
<td>65.3</td>
<td>63.3</td>
<td>55.8</td>
<td>52.8</td>
<td>23.0</td>
<td>552</td>
<td>67.0</td>
<td>66.2</td>
</tr>
<tr>
<td>8</td>
<td>5.3</td>
<td>60.8</td>
<td>58.8</td>
<td>49.7</td>
<td>46.7</td>
<td>24.5</td>
<td>547</td>
<td>67.0</td>
<td>60.1</td>
</tr>
<tr>
<td>10</td>
<td>5.9</td>
<td>59.3</td>
<td>57.3</td>
<td>47.8</td>
<td>44.8</td>
<td>25.0</td>
<td>545</td>
<td>67.0</td>
<td>58.2</td>
</tr>
<tr>
<td>16</td>
<td>7.5</td>
<td>56.2</td>
<td>54.2</td>
<td>43.7</td>
<td>40.7</td>
<td>25.0</td>
<td>543</td>
<td>67.0</td>
<td>54.1</td>
</tr>
<tr>
<td>20</td>
<td>8.4</td>
<td>54.8</td>
<td>52.8</td>
<td>41.8</td>
<td>38.8</td>
<td>25.0</td>
<td>542</td>
<td>67.0</td>
<td>52.2</td>
</tr>
<tr>
<td>25</td>
<td>9.4</td>
<td>53.3</td>
<td>51.3</td>
<td>39.8</td>
<td>36.8</td>
<td>24.3</td>
<td>541</td>
<td>67.0</td>
<td>50.2</td>
</tr>
<tr>
<td>31.25</td>
<td>10.5</td>
<td>51.9</td>
<td>49.9</td>
<td>37.9</td>
<td>34.9</td>
<td>23.6</td>
<td>540</td>
<td>67.0</td>
<td>48.3</td>
</tr>
<tr>
<td>62.50</td>
<td>15.0</td>
<td>47.4</td>
<td>45.4</td>
<td>31.9</td>
<td>28.9</td>
<td>21.5</td>
<td>539</td>
<td>65.6</td>
<td>42.3</td>
</tr>
<tr>
<td>100</td>
<td>19.1</td>
<td>44.3</td>
<td>42.3</td>
<td>27.8</td>
<td>24.8</td>
<td>20.1</td>
<td>538</td>
<td>62.5</td>
<td>38.2</td>
</tr>
<tr>
<td>200</td>
<td>27.6</td>
<td>39.8</td>
<td>37.8</td>
<td>21.8</td>
<td>18.8</td>
<td>18.0</td>
<td>567</td>
<td>58.0</td>
<td>32.2</td>
</tr>
<tr>
<td>250</td>
<td>31.1</td>
<td>38.8</td>
<td>36.6</td>
<td>19.8</td>
<td>16.8</td>
<td>17.3</td>
<td>536</td>
<td>56.5</td>
<td>30.2</td>
</tr>
<tr>
<td>300</td>
<td>34.3</td>
<td>37.1</td>
<td>35.1</td>
<td>18.3</td>
<td>15.3</td>
<td>16.8</td>
<td>536</td>
<td>55.3</td>
<td>28.7</td>
</tr>
<tr>
<td>400</td>
<td>40.1</td>
<td>35.3</td>
<td>35.1</td>
<td>15.8</td>
<td>12.8</td>
<td>15.9</td>
<td>536</td>
<td>53.5</td>
<td>26.2</td>
</tr>
<tr>
<td>500</td>
<td>45.3</td>
<td>33.8</td>
<td>31.8</td>
<td>13.8</td>
<td>10.8</td>
<td>15.2</td>
<td>536</td>
<td>52.0</td>
<td>24.2</td>
</tr>
</tbody>
</table>

(c) All cables shall have the following capacities:

(i) Category 6a, 4 twisted-pair.

(d) Twisted pair cables shall have the following characteristics, or according to TIA/EIA:

(i) Nominal impedance: 100 Ohms +/- 5%,

(ii) Performance 500 MHz

(iii) Low Smoke Zero Halogen outer sheath,

(iv) Metric marking indicating type of cable, year, ref., number,

(v) less than or equal to 9.0 mm (0.354 in).

(vi) Installation temperature: -5°C / +40°C,

(vii) Operating temperature: 20°C / +60°C.

(viii) Colour code TIA/EIA

(ix) Conform to standards ISO/IEC 11801

(x) Ed. 2.0, EN 50173-1 and TIA/EIA 568C
5 CAT3 Copper Cables

(a) CAT 3 copper cable shall be used as a horizontal cabling between analog telephone outlets and its corresponding IDF and also as a backbone cabling between IDF and the MDF.

(b) Horizontal Cat 3 cabling shall be standard 2 pairs and backbone cat3 cabling shall be standard 25 pairs.

(c) CAT3 copper cables shall comply, as a minimum requirement, with standard TIA/EIA-568-B.1 and ISO/IEC11801 defined for class C cables with swept frequencies up to 16MHz and speed up to 10Mbps.

(d) Cat 3 copper cables shall meet the following values:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Attenuation (DB/100m)</th>
<th>NEXT (DB)</th>
<th>PSNEXT (DB)</th>
<th>ELFEXT (DB/100m)</th>
<th>PSELFEXT (DB/100m)</th>
<th>RL</th>
<th>Delay</th>
<th>PSANEXT</th>
<th>PSAACRF</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>7.5</td>
<td>56.2</td>
<td>54.2</td>
<td>43.7</td>
<td>40.7</td>
<td>25.0</td>
<td>543</td>
<td>67.0</td>
<td>54.1</td>
</tr>
</tbody>
</table>

(e) Cat 3 copper cables shall have the following characteristics, or according to TIA/EIA:

(i) Nominal impedance: 100 Ohms +/- 5%,

(ii) Performance 16 MHz

(iii) Low Smoke Zero Halogen outer sheath,

(iv) Metric marking indicating type of cable, year, ref., number,

(v) less than or equal to 4.39 mm (0.173 in) for 2 pairs

(vi) and 10.14 mm (0.399in) for 25 pairs.

(vii) Installation temperature: 0°C / +50°C,

(viii) Operating temperature: -20°C / +60°C.

(ix) Colour code TIA/EIA

(x) Conform to standards ISO/IEC 11801

(xi) Ed. 2.0, EN 50173-1 and TIA/EIA 568-B.1

14.2.5 Connection

1 Optical Fiber Connector

(a) Optical fiber connectors and pigtails shall be LC single in accordance with ISO 11801.

(b) Given the type of fiber, ceramic end fitting for multi-mode or single-mode shall be used.

(c) Connectors shall comprise sleeve for 900 µm.

(d) Connectors shall be crimp-lock type without glue.

(e) 900 µm sleeved cables shall be directly connected on the fiber.
(f) Optical access point (dual) shall be provided in dedicated 45 x 45 LC duplex module with shutter.

(g) Connection of tube type fiber optic cables shall be ensured by fusion with LC multi-mode or single-mode pigtails.

(h) Each pigtail shall have the following attenuation: 0.15 dB at 850 nm for multi-mode and 1310 nm for single-mode.

(i) Splicing shall be done through automatic programmable splicing system.

(j) Splicing shall produce losses of 0.15 dB at 850 nm for multi-mode and at 1310 nm for single mode.

2 RJ45 Connectors/Jacks

(a) The Contractor shall use RJ45 8-points connectors complying with Cat 6A – ISO 11801.

(b) The Contractor shall provide 8 position / 8 conductors.

(c) The connectors shall be F/UTP.

(d) The connectors shall be connected with simple tool allowing simultaneous connection of 4-pairs cable and control of un-twist operation.

(e) The connectors shall be provided with faceplates for communication outlet in gang widths. Faceplates shall be modular 2 and 4. Contractor shall coordinate the final location of faceplates and number of modules according to number of consecutive outlets.

(f) Faceplates shall be fitted with spring shutter and label holder.

3 RJ11 Connectors/Jacks (ANALOG TELEPHONE OUTLET)

(a) The Contractor shall use RJ11 2-points connectors complying with Cat 3 – ISO 11801.

(b) The Contractor shall provide 6 position / 2 conductors.

(c) The connectors shall be F/UTP.

(d) The connectors shall be connected with simple tool allowing simultaneous connection of 2-pairs cable and control of un-twist operation.

(e) The connectors shall be provided with faceplates for communication outlet in gang widths. Faceplates shall be single type. Contractor shall coordinate the final location of faceplates and number of modules according to number of consecutive outlets.

(f) Faceplates shall be fitted with spring shutter and label holder.

4 RJ45 Patch Cords

(a) The Contractor shall provide Cat 6A patch cords complying with ISO 11801 and able to support Gigabit 1000 Base Tx.

(b) Patch cords shall have the following characteristics:

   (i) Impedance: 100 Ohms +/-5% up to 500 MHz,

   (ii) Stranded conductors,

   (iii) 4-pairs cable capacity,
(iv) Low Smoke Zero Halogen outer sheath,
(v) Marked at each meter,
(vi) RJ45 plugs complying with EIA/TIA 568C,
(vii) Length: 0.5, 1, 2, 3, 5 and 10 meters,
(viii) Labeling through at least 5 color inserts: blue, yellow, black, red and green.

(c) The Contractor shall supply patch cords in the same quantity for each color.

(d) The Contractor shall provide patch cords in different lengths as required during implementation. These are usually identified (for guidance only) as follows:
   (i) 5% of 0.5 m patch cords,
   (ii) 5% of 1 m patch cords,
   (iii) 30% of 2 m patch cords,
   (iv) 45% of 3 m patch cords,
   (v) 10% of 5 m patch cords,
   (vi) 5% of 10 m patch cords.

(e) Almost all patch cords shall be straight connected, but the Contractor shall provide optionally 2% of cross-connected type patch cords.

5 Optical Fiber Patch Cords

(a) Optical fiber patch cords shall have the following characteristics:
   (i) Two-fibers multi-mode patch cords compatible with the type of fiber to be used,
   (ii) Low Smoke Zero Halogen outer sheath,
   (iii) Metric marking indicating type of cable, year, ref., number,
   (iv) LC duplex connectors at each end,
   (v) Cable reinforced with aramid fibers,
   (vi) Length of 1, 2, 3, 5 and 10 meters,
   (vii) Labeling with at least 5 colors,
   (viii) Protected by sleeve at each end.

(b) The Contractor shall provide optical fiber patch cords in the same quantity for each color.

(c) The Contractor shall provide patch cords in different lengths as required during implementation. These are usually identified (for guidance only) as follows:
   (i) 5% of 1 m patch cords,
   (ii) 20% of 2 m patch cords,
   (iii) 50% of 3 m patch cords,
   (iv) 20% of 5 m patch cords,
   (v) 5% of 10 m patch cords.
14.3 EXECUTION

14.3.1 Project Management

1 The Contractor is required to supply a complete description (Project Plan) of the key activities required for the installation of the system.

2 In the project plan, the Contractor shall include a project organization chart with the reporting relationships of project team members and other key personnel. An escalation matrix should also be included.

3 It is essential that the installation of the new system be as transparent as possible to the users. There should be no service interruptions and no perceived degradation in the quality of service.

4 A master project schedule must be included, along with a work responsibility matrix, identifying the tasks the Contractor will perform and the tasks the Employer is expected to perform to successfully implement the new system.

14.3.2 Installation

1 General

(a) Acceptance of works will be restricted to the equipment and installations complying with the approved submittals, approved shop drawings, and the Employer site Engineer agreement.

(b) The Contractor has to carry out any site works under direct supervision of qualified technicians who are to be well trained with qualified Manufacturer experience.

(c) Site workmanship of any network component has to be limited to the layout and fixation, and inter-wiring of various items of the ready-made equipment.

(d) In addition to the above, the Contractor is also expected to supply the following:

   (i) Coordination meetings with the Project authorities, the Employer’s departments, operators, existing contractors, etc.
   (ii) Progress reports and Progress reviews,
   (iii) Insurance for the Transport of the equipment,
   (iv) Quality Assurance setup and management,
   (v) Document Management,
   (vi) Configuration Management for the duration of the Project,
   (vii) User documentation and training including textbooks,
   (viii) Worksite expenses (Setup and removal of temporary offices, Worksite vehicles, Site Offices, Computers, Printers, Desks, etc.),
   (ix) Archival.

2 Site Survey

(a) Examine all the technical rooms where equipment are to be deployed:
(i) Identify equipment location,
(ii) Identify links on patch panels,
(iii) Identify and check general power supply and grounding,
(iv) Confirm feasibility for each technical room before starting to deploy.

(b) Proceed with installation only after unsatisfactory conditions have been corrected.

3 Examination

(a) Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

4 Cabinet Installation

(a) General

(i) Prior to installation, the Contractor shall mark location of cabinets on the floor and/or walls.
(ii) The Contractor shall install the cabinets in full coordination with other system cabinets installed in the communication room, if any.
(iii) The Contractor shall install and adjust rack enclosure to allow access and to meet standard requirements.
(iv) Cables shall enter the equipments racks or enclosures in such a manner that all doors or access panels shall open and close without disturbing or damaging the cables. Cables shall be installed and fastened without causing sharp bends or rubbing of the cables against sharp edges. Cables shall be fastened with hardware that will not damage or distort them.
(v) All vertical and under floor cable trays shall be covered.
(vi) The Contractor shall meet EMC requirements.
(vii) The Contractor shall ground all contractor installed equipment to eliminate all shock hazard and to minimize all ground loops, common mode returns, noise pickup, crosstalk, etc. An isolated ground bar with test clamp shall be installed in each cabinet.
(viii) Cabinet shall be bonded with copper cable equivalent to at least 35 mm².
(ix) The Contractor shall be in charge of any functional ground connections through physical contact with installed equipment.
(x) Cable shields shall be bonded to the cabinet with 50 mm stranded copper tape at only one end of the cable run. Cable shield shall be insulated from each other, face plates, equipment racks, enclosures or cabinets; except at the system common ground point.

(b) 19" Cabinet Specific Requirements

(i) Each cabinet (or enclosure) shall have accessible front and rear locking panels/doors after installation.
(ii) 800 x 800 minimum space shall be provided on each side of access panels.

(iii) When enclosures will be mounted side by side, only two outside panels shall be included. No space shall be allowed between two cabinets. Cabinet shall be bolted together and bolted to floor leaving possible removing of wooden floor module under the given cabinet.

(iv) Vertical cable runway shall be installed in a manner such that it will not impede installing a future rack next to the given rack nor interfere with the installation of a cable channel.

(v) The Contractor shall cover edges of cables pass in a through hole in cabinets with protective plastic or nylon grommetting.

(vi) The Contractor shall be in charge of cabinet adjusting making sure that the weight is balanced on its four feet. Enclosures/cabinets shall be installed plumb and square.

(c) 19" Wall Mounted Cabinet Specific Requirements

(i) Each wall mounted enclosure/cabinet shall be permanently attached to the building structure and held firmly in place.

(ii) Each wall mounted cabinet shall be hinged at the 4 wall anchor points, the upper side at 1900 mm from the floor to allow easy access to its inside. Load of 100 Kg shall be acceptable without damaging fixing devices or the enclosure.

(iii) Each wall mounted cabinet shall be with standard knockout holes for conduit connection, trays or cable entrance on upper and bottom side.

(iv) Associated trays or conduits shall be installed in line with cabinet entry holes.

(v) A spare space of 600 mm shall be provided on each side of the cabinet to allow access and door opening.

(d) Rack Mounted Equipment

(i) The Contractor shall install rack mounted equipment according to locations, elevations, and plan views developed by the Contractor and approved by the Employer’s Representative.

(ii) Rack mounted equipment shall be bolted with at least 4 mounting screws for support.

(iii) Cable guide shall be installed between each 2U rack unit set of equipment to insure patch cable run and adequate air circulation.

(iv) All rack-able equipment shall be installed 150 mm from the door and securely mounted in a manner that shall provide access to the connections for testing and allow sufficient cable room for the doors or access panels to open and close without disturbing the cables.

(v) Distribution and backbone cables shall enter from rear of optical patch panels.

(vi) Cables shall be maintained with D-Rings.

(vii) Each cable shall enter patch panel through adequate bushings and inserts where required by Manufacturer’s installation manuals/sheets.
(viii) All grounding and bonding work shall comply with NEC and ANSI/TIA/EIA standards.

(ix) The Contractor shall bond all metallic raceway, racks, cable runway, enclosure, and other metallic hardware used for SCN to the dedicated bus bar.

(x) The Contractor shall ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.

(xi) All spare or unused space shall be obstructed through blank panels.

5 Equipment Data

(a) Submit complete technical data including Manufacturer's catalogues and specifications, system description including operational aspects, system features, and components.

6 Shop and Construction Drawings

(a) Submit drawings for approval.

(b) Constraints to be studied by the Contractor as part of its necessary Shop-Drawing development:

(i) The integration of the SCN hardware (equipment, cables, cabling routing, etc.) shall be studied in such a way to deliver on site a package ready for installation.

(ii) The Contractor shall ensure the full coordination between the SCN constraints and other systems or any other interfaced systems.

(iii) The Contractor remains responsible of the proper coordination as to avoid any technical mismatches.

(iv) All the SCN System shall be studied, installed, and tested in order to offer an easy maintenance and access.

(v) All coordination due by the Contractor shall always cover all aspects of Shop Drawing elaboration, manufacturing, construction, testing, and commissioning, to achieve comprehensive systems in proper and efficient working order.

(vi) The final coordination on site with Civil Works, Facades, Architecture, HVAC, Plumbing, Electrical and any other construction aspect, remains the duty of the Contractor.

7 Detailed System Schematic Diagrams

(a) Exact routing of cables, giving type and size,

(b) Exact location of equipment, components, cabinets, and racks as well as patch panels, etc. in communication rooms.

8 Typical Installation Details of the System Components

(a) After installation, the Employer shall be able to perform hardware configuration changes, to redefine any new mapping and modifications as desired without the services of the Installer or Manufacturer.
9 Coordination with Other Works

(a) It is under the Contractor responsibility to carry out any coordination between its own installations and other Project entities and systems.

(b) The layout shop drawings have to be used as a guideline and need to be improved before any site workmanship.

(c) The layout shop drawings are to also reveal the measures taken therein, and every fixation principle, and are to be approved by the Employer’s Representative.

(d) For this purpose any starting of work shall be subject to the Employer site Engineer approval.

10 Layout of Equipment

(a) Equipment is to be laid out properly in communication rooms in a way to reserve relevant space for maintenance activities. This space shall also include any future expansion of the system.

(b) Equipment is to be laid out as per the approved shop drawings.

(c) After the proper layout of all equipment is accomplished, all components are to be labeled, and marked according to an approved labeling designations and materials.

11 Installation Instructions

(a) Install equipment to comply with Manufacturer’s written instructions.

(b) More precisely:

(i) Use listed cable in environmental air spaces, including plenum ceilings.

(ii) Install cable using techniques, practices, and methods that are consistent with a Structured Cabling Network (SCN) category rating of components and that ensure SCN category performance of completed and linked signal paths, end to end. Limit amount of cable untwisting to those defined by the Standard.

(iii) Install cable without damaging conductors, shield, or jacket.

(iv) Do not bend cable in handling or in installing to smaller radii than minimums recommended by the Manufacturer.

(v) Secure and support cable at intervals not exceeding 750 mm and not more than 150 mm from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

(vi) Wiring within communication rooms: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by the Manufacturer.

(c) Cleaning: after completing system installation, inspect premises. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
12 Wiring Method
   (a) Install wiring in raceway.
   (b) Conceal cable and raceway.

13 Splices, Taps, and Terminations
   (a) Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.

14 Impedance and Signal Levels
   (a) Match input and output impedance and signal levels at signal interfaces. Provide matching networks where required.

15 Identification
   (a) Identify system components complying with applicable requirements and the following Specifications.
   (b) Use a unique hierarchical alphanumeric designation in order to label:
      (i) Structured Cabling Network equipment and components,
      (ii) Ports to terminals connected to the equipment.
   (c) Provide an identification database.
   (d) Color code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.

16 Wall Mounting Outlets
   (a) Flush mounted.

17 Floor Mounting Outlets
   (a) Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

18 Furniture Mounted
   (a) Outlet installed into furniture in places that indicated in drawings

19 Weatherproof Equipment
   (a) Install units that are mounted outdoors, in damp locations, or where exposed to weather consistent with weatherproof rating requirements as IP65 at least.

20 Cleaning
   (a) After completing system installation inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
21 Supervision

(a) Installation shall be supervised and tested by a representative of the Manufacturer of the system equipment.

(b) The work shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this work.

22 Security

(a) Coordinate with the Employer to procure general security conditions during building site.

(b) Check that drain conductors and equipment are grounded to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup and other impairments.

(c) Patch wiring must be traceable; Keep a database of patches installation up to date.

14.3.3 Wire And Cable

1 Principles

(a) All wiring and cable shall be installed in metal raceways or within equipment.

(b) Conductors within equipment enclosures shall be carefully cabled and laced.

(c) Individual conductors shall be tagged with markers indicating the function, source, and destination of all cabling, wiring and terminals.

(d) All cables and wires shall be identified, utilizing heat shrink, pre-printed, wire markers.

(e) Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

(f) Separation of Wires: Comply with standard rules for separating unshielded copper communication and data-processing equipment cables from potential EMI sources, including electrical power lines and equipment.

(g) Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.

(h) Use splice and tap connectors compatible with media types.

2 Cables Installation

(a) The Contractor shall employ the latest installation practices and materials in compliance with ANSI/TIA/EIA 568C requirements.

(b) Cables shall be installed in a continuous (non-spliced) manner.

(c) The bending radius and pull strength requirements of all cable as detailed in ANSI/TIA/EIA 568C and the Manufacturer’s installation recommendations shall be strictly observed during handling and installation.
(i) Pull cables simultaneously where more than one cable is being installed in the same raceway.

(ii) Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation.

(iii) Use pulling means, including fish tape, cable, rope, grips that will not damage media or raceway.

(d) Cables shall be installed and fastened without causing sharp bends or rubbing of the cables against sharp edges. Cables shall be fastened with hardware that will not damage or distort them at intervals not exceeding 3 rings/meters. Cables shall be tied or clamped. Attaching cables to pipes, electrical conduits, mechanical items, or ceiling support system is not acceptable. Tie wraps shall conform to Manufacturer’s installation recommendations.

(e) The Contractor shall lay cables via the shortest route directly to the distribution node.

(f) The Contractor shall lay and dress all cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance.

(g) Backbone cables shall be separately routed using different trays.

3 Cable Termination

(a) RJ45 termination shall conform to EIA/TIA 568C.

(b) RJ45 terminations shall be connected as per the following requirements:
   (i) Use of adapted connection tool,
   (ii) Withdraw cable jacket up to 20 mm,
   (iii) Untwist pairs up to 13 mm,
   (iv) Length of conductor after contact shall not exceed 1 mm,
   (v) Screen shall be left around pairs up to 5 mm,
   (vi) Loops of cables in racks are not allowed, only enough spare length for connector replacement shall be provided.

4 Optical Fiber Connection

(a) All connectors shall be of high quality materials and construction.

(b) All single-mode fiber strands of backbone shall be terminated with simplex LC connector through fusion splice.

(c) Connectors shall be crimp lock-style and terminated as per Manufacturer’s recommendations.

(d) Connectors shall provide minimal signal reflection and low loss connections.

(e) Provide 1 to 2 meters service loop at each end.

5 Number of Conductors

(a) As recommended by system Manufacturer for functions indicated.
6 Check-In and Tests
   (a) After installation, and before termination, all wiring and cabling shall be checked and tested to ensure that there are no grounds, opens, or shorts on any conductors or shields.
   (b) A V.O.M. shall be utilized to accomplish these tests and a reading of greater than 20 Mega ohms shall be required to successfully complete the test.

7 Visual Inspection
   (a) Visually inspect wire and cable for faulty insulation prior to installation.
   (b) Protect cable ends at all times with acceptable end caps except during actual termination.
   (c) At no time shall any optical fiber be subjected to a bend less than a 150 mm radius.

8 Protection
   (a) Protect wire and cable from kinks.
   (b) Provide grommets and strain relief material where necessary, to avoid abrasion of wire and excess tension on wire and cable.

9 Splices, Taps, and Terminations
   (a) Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

10 Identification
   (a) Identify components, conductors, and cables.
   (b) Color code conductors, and apply wire and cable marking tape to designate wires and cables so media are identified and in coordination with system wiring diagrams.

14.3.4 Raceways and Cable Trys

1 Raceways
   (a) Requirements:
      (i) Surface raceway shall be constructed and installed for all exposed communications outlets. The Contractor shall match as closely as possible the existing wall finish but shall not paint surface raceway. Surface raceway shall be:
         1) Constructed and installed per Article 352 of the NEC or any relevant local standard, mechanically and electrically continuous and shall be bonded in accordance with NEC and ANSI/TIA/EIA-607 codes and standards.
         2) Constructed and installed according to ANSI/TIA/568C and 569 standards and shall have a radius control at all bend points in accordance with the cable’s Manufacturer recommendation.
3) Securely supported at intervals not exceeding 3 meters or in accordance with Manufacturer’s installation sheets.

(b) Use communications cable tray wherever possible for low voltage cabling.

(c) Exposed raceway below 2.4 meters and in dry locations shall be rigid steel conduit.

2 Cable Trays

(a) No telecommunications containment including cable trays, trunking, ducts etc. shall be loaded more than 60% of the available space. The Contractor is responsible to size the containment appropriately taking into account all systems and the type of cables to be used based on selected Manufacturer for each system.

(b) In general, telecommunications containment route shall follow the electrical containment route with sufficient clearance. However, any other routes followed shall be to the approval of the Employer’s Representative.

14.3.5 Field Quality Control

1 The Contractor shall submit to the Employer the manufacturing and shipment schedules for all equipment and/or materials at least one month prior to the time of packing for shipment as long as the lead time available is sufficient or such shorter period as may fit the actual circumstances. Should the Employer’s Representative fail to attend on the specified date for inspection, the Contractor shall proceed with shipment and carry out the relevant tests itself. The Contractor shall provide the Employer a copy of the recorded factory results made under its cognizance before shipment. If the test results show that the equipment and/or materials do not comply with the Specifications, such non-complying equipment and/or materials shall be rejected and shall not be shipped until repaired or replaced and tested again. In such case, the Contractor shall be held liable for any resulting delay. In all cases, the Contractor shall be responsible for the compliance of his equipment and materials with the Contract's specifications.

2 Testing: On installation of network components, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

3 Correct malfunctioning units at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

14.3.6 Labeling And Administration

1 Labels

(a) They are required for equipment, cabinets, racks, bonding conductors, riser cables, access points, etc. Labels shall comply with EIA/TIA 606.

2 Rack Labeling

(a) Racks shall be labeled sequentially and shall be of the form “01”to“0 xs”.

(b) Labels shall be of the minimum size of 100 x 50 mm, screwed yellow unit
with 15 mm black letters/numbers.

3 Rack Mounted Equipment Labeling

(a) RJ45 and fiber patch panel for horizontal distribution shall be labeled sequentially within a given rack and shall be of the form “01” to “0 xs” from the top to the bottom. Labels shall be of the size of 20 x 15 mm, adhesive yellow unit with 10 mm black letters/numbers or other prefabricated label system depending of the Manufacturer.

(i) Fiber LC duplex ports shall be labeled sequentially within a given fiber patch panel and shall be of the form of 8 mm twin number; 01 to 12.

(ii) RJ45 ports shall be labeled on the dedicated label holder with 8 mm numbers; 01 to 24 for 24 ports patch panel or 01 to 48 for 48 ports patch panels.

(b) Fiber patch panel for vertical distribution shall be labeled sequentially within a given rack using red label for multi-mode fiber optic cable and black label for single-mode fiber optic cable, with 8 mm white number 01 to 12, to each LC duplex port. Each panel shall be labeled with “Fiber Optic cable” 80 x 10mm, 8 mm number, black or red label.

(c) Outlet Labeling:

(i) All RJ45 and LC duplex outlets shall be labeled.

(ii) Final outlet label shall be submitted and approved at construction stage.

(d) Backbone/Riser Cable Labeling:

(i) Cables shall have labels affixed at each end.

(ii) Labels shall be of permanent identification type, adhesive, using indelible ink on white print-on material for outdoor and high temperature applications.

(e) Termination Cable Labeling:

(i) All cables shall have labels affixed at each end as per EIA/TIA 606 standard.

(ii) Labels shall be of permanent identification type, adhesive, using indelible ink on white print-on material for outdoor and high temperature applications.

(f) Cable Tray Labeling:

(i) Cable trays shall be labeled at 5 meters intervals with engraved adhesive yellow with black letters label as per the following example:

(ii) Conduits and dado trucking dedicated to SCN shall be labeled at 5 meters intervals with adhesive yellow label (60 x 60 mm) as per the following example:

<table>
<thead>
<tr>
<th>DEDICATED TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRUCTURED CABLING NETWORK</td>
</tr>
<tr>
<td>DEDICATED TO</td>
</tr>
<tr>
<td>STRUCTURED CABLING NETWORK</td>
</tr>
</tbody>
</table>
14.3.7 Grounding

1 Precaution

(a) Properly ground each piece of electronic equipment prior to applying power.

(b) Properly ground all shielded wire shields to the appropriate clean earth ground at the equipment end only, not at the remote or device end.

2 Principles

(a) Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

3 Grounding Considerations

(a) General

(i) Grounding systems are normally an integral part of the specific signal and telecommunications wiring system that they protect. Besides helping protect personnel and equipment from hazardous voltages, the grounding system may reduce the effect of electromagnetic interference (EMI) on the Structured Cabling Network. Improper grounding can produce induced voltages and those voltages can disrupt other data or telecommunications circuits.

(ii) When compatible with required electrical codes, the grounding instructions and requirements of the equipment Manufacturer should also be followed. The grounding requirements of the EIA/TIA 607 shall be followed.

(b) Considerations

(i) Ensure that the installation conforms to proper practices and requirements.

(ii) Ensure that each SCN cabinet and rack has an appropriate grounding bus bar that is connected to the dedicated building ground by a 35 mm² ground wire.

(iii) Ensure that grounding is available for all system equipment and components and equipment required for maintenance and testing.

(iv) Ensure that all metal cable trays shall be bonded to ground. Cable tray shall not be used for a ground path.

14.3.8 Factory Tests

1 Factory Acceptance Tests

(a) The Contractor shall carry out any Factory Acceptances Tests, in Manufacturer’s factory itself, before any site delivery, in order to show to the Employer site Engineer that the system is able to satisfy site technical requirements of the equipment specifications.

(b) Some of the functional or performance tests, which cannot be conducted in a simulated environment, due to their nature and complications, may
subject to the Employer’s Representative's approval be combined with the On Site Tests.

(c) All travels and trips costs shall be provided by the Contractor for five (5) representatives to be nominated by the Employer.

2 Test Specifications

(a) Following the methodology presented in the Test Plan, all tests are to be carried on according to Test Specifications, which are submitted by the Contractor and approved by the Employer’s Representative.

(b) The tests are to cover every aspect related to the specification of the system and its operation; including, but not limited to, visual inspections, measurements, and operation.

(c) All Factory Acceptance Tests need to be carried out in the presence of the Employer’s Representative unless otherwise agreed by the Employer’s Representative. The Employer’s Representative will sign off the testing document on satisfactory completion of the tests.

(d) The results of the Factory Acceptance Tests, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer’s Representative.

3 Equipment Tests

(a) Equipment is to be tested for quality and operation at the factory, and test certificates and reports, certified by an official testing authority, are to be submitted to the Employer’s Representative before dispatch of equipment to site.

14.3.9 On Site Tests and Inspection

1 On Site Assembly Verification

(a) The purpose of this phase is to check the assembly and the connection of the equipment without any power supply.

(b) Any verification can give raise to a punch list item either because of an anomaly or a non-conformity with the tender documents.

(c) The punch lists are collated for each module and the phase report is only released when all the stipulations on the punch lists are cleared.

2 Test Specifications

(a) Following the methodology presented in the Test Plan, all tests are to be carried on according to Test Specifications, which are submitted by the Contractor and approved by the Employer’s Representative.

(b) The tests are to cover every aspect related to the specification of the system and its operation including, but not limited to, visual inspections, measurements, and operation.

3 On Site Cable Tests

(a) Cables shall be tested to ensure that no damage have occurred to them
during transportation to site and/or during the course of pulling in and laying.

(b) Test records shall be provided on a form approved by the Employer's Representative. The form shall include test result for each cable in the system.

(c) Each cable tested shall be submitted on the form with identifications as discussed under Labeling and Administration above.

(d) The form shall include the ID, outcome of the test, indication of errors found, cable length, re-test results, and signature of technician completing the tests.

4 Twisted Pair Cables

(a) Test Cat 6A cables for compliance to ANSI/TIA/EIA 568C and ISO/IEC 11801 25N780 Standards.

(b) Test each end-to-end link, utilizing 0-500 MHz sweep tests, for continuity, polarity, NEXT, attenuation, installed length, wire map, impedance, resistance, ELFEXT, and ACR. Each cable shall be tested in both directions.

(c) Test with building electrical systems powered on (i.e. lights, HVAC, etc.)

(d) Testing device shall be Level 3 testing instrument, re-calibrated within the last 6 months, with the most current software revision based upon the most current EIA/TIA testing guidelines, 500 MHz rated, capable of storing and printing test records for each records for each cable within the system.

5 Fiber Optic Cables

(a) Test fiber optic cable strands (with terminations) in accordance with EIA/TIA methods, procedures, and standards.

(b) Multi-mode Cable: Test at both 850 and 1300 nm. Test each end-to-end link. Multi-mode fiber optic cables shall be tested for correctness of termination, compliance to attenuation values and acceptable dB loss.

(c) Single-mode Cable: Test at both 1310 and 1550 nm. Test each end-to-end link. Single-mode fiber optic cables shall be tested for correctness of termination, compliance to attenuation values and acceptable dB loss (less than 0.5 dB) in accordance with ISO 11801 25N780.

(d) Patch cables shall also be tested according to the above criteria.

(e) Testing device shall be an approved fiber optic Transmission Loss Test Instrument (OTDR).

6 Inspection

(a) Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

7 Pre-Testing

(a) Align and adjust system and perform pre-testing of all components, wiring, and functions to verify compliance with specified requirements.
(b) Correct all deficiencies by replacing malfunctioning or damaged items with new items.

8 Manufacturer's Field Services

(a) Engage a factory authorized service representative to inspect field assembled components and equipment installations and perform system pre-testing, testing, adjustment and programming.

(b) Report results in writing.

9 Procedure

(a) Notify the Employer's Representative not less than 30 days in advance, of proposed schedule, procedures and tests to be used in operational testing.

(b) Conduct operational tests only with the Employer's Representative present.

10 Report

(a) Prepare a written report of observations, inspections, tests, and results, including:

(i) A complete listing of every device and circuit,

(ii) Date of each test and retest, and by whom,

(iii) Results of each test and, if failure occurred, corrective action taken prior to retest.

11 Certification

(a) The Contract shall certify that all devices, circuits, and total system are finally tested successfully.

12 Operational Tests

(a) Schedule tests after pre-testing has been successfully completed.

(b) Perform operational system tests to verify compliance with Specifications.

(c) Schedule tests with at least seven days advance notice of test performance.

13 Integrated Tests with Other Contractors

(a) The Contractor shall make equipment available for testing and demonstrating various features specified.

(b) The test procedures shall reflect the sequence of tests to be performed.

(c) Typical test segments shall include but shall not be limited to the following:

(i) Communication Tests shall be performed for the serial or LAN interface to ensure that proper communication can be established between data network equipment and the interfacing systems.

(ii) Point-to-Point Tests shall be performed on the Structured Cabling Network to the interfacing systems in order to verify the functionality.

(d) Retesting: Correct deficiencies and retest until total system meets
requirements of the Specifications and complies with applicable standards. Prepare written records of tests.

(e) Schedule testing with at least seven days advance notice.

14.3.10 Training

1 The Contractor is required to conduct end-user training on the Employer’s premises, tailored specifically to the Employer particular requirements in the use, configuration and maintenance of the Structured Cabling Network equipment and components.

2 Training shall be provided for Technical Staff of the Employer in the Testing, Maintenance and Fault Location of the Structured Cabling Network.

3 For each product and/or application, the Contractor shall provide a detailed description of the training the Manufacturer will provide.

4 Trainers

(a) All training shall be certified training by Manufacturer and trainers shall be approved by the Employer before starting.

(b) Engage a factory authorized service representative to explain programming and operation of system and to train Employer's personnel on procedures and schedules for maintaining, programming, operating, adjusting, troubleshooting, and servicing the system.

5 Training Program

(a) Scope

(i) Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and/or maintain the equipment, systems, and facilities provided and installed under this Contract, and to ensure a smooth transition between construction and operations activities.

(b) Language

(i) Training shall be conducted in English and Arabic.

(c) Training Aids

(i) Training aids shall include:

1) Approved Operation and Maintenance (O & M) manual(s) prepared by the Contractor as part of this Contract,

2) Training manuals, including course outline, basic text of instructions modules, and trainee workbook,

3) Films, slides, video tape(s),

4) Charts, models, hand-outs, catalogues,

5) Samples and other visual,

6) Written aids to complement instruction.

(ii) In addition, spare parts and other special hardware shall be provided
to support “hands-on” familiarization with the equipment or systems.

(d) Training Manuals

(i) Training manuals shall be provided for each training course covering both the classroom and on-the-job phases.

(ii) The organization of the manuals shall follow the same sequence as the course’s scheduled presentation of material, providing such additional background and supplementary information, as a trainee may need to understand the O & M manuals.

(iii) There shall be as many Training Manual types as Trainees categories.

(e) Training Execution

(i) Scope

1) Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training.

(ii) Contents

1) Training course can be broken down into modules either classroom lecture or “On-the-job” training.

2) In case of lecture, it is the Employer responsibility to provide the classroom for the duration of the course.

3) No lecture module should exceed 2 hours time.

4) “On-the-job” training can be scheduled for entire 8 hour shift.

5) Handouts must support each module; the collation of the Handouts forms the Training Manual.

6) Laboratory equipment, spare parts, and mock-up models may be used for theoretical orientation.

7) However, practical “hands-on” familiarization shall be provided on equipment that is either installed and operable or ready to be installed and capable of being operated. System spares of special hardware items may be used to support “hands-on” familiarization as long as said spares are returned to inventory in satisfactory condition in accordance with approved procedures.

(iii) Proficiency

1) At designated intervals each trainee’s proficiency levels shall be determined by written, oral and practical performance tests.

14.3.11 Maintenance And Warranty

1 The Structured Cabling Network and all associated equipment in the Contractor’s solution shall be warranted by the Contractor and by the Manufacturer to be free of defects in hardware and workmanship for a period of at least two years from the date of Substantial Completion.

2 During the warranty period and any subsequent maintenance agreement, any defective components shall be repaired or replaced at no cost to the Employer.
3 All system maintenance during the warranty period and under any subsequent maintenance agreements shall be performed by the Contractor organization using personnel employed full time by the Contractor and at no additional cost to the Employer other than those charges stipulated to maintain the warranty.

14.3.12 Logistical Support

1 The Contractor should identify the address of the Manufacturer's local service centers and the number of service personnel trained on the system.

14.3.13 Guidelines For Documentation Transmittal

1 Content of the Transmittals

(a) Contractor to prepare detailed drawings, design calculations, technical data sheets and samples and submit the same for review by the Employer’s Representative. The Contractor shall submit the following key elements to the Employer’s Representative for review:

(i) Detailed layout showing the marking and/or the equipment as required,

(ii) Manufacturers’ Catalogues,

(iii) Provide all relevant Testing Certificates,

(iv) Inventory label for each item supplied under this Contract. Labels shall be submitted for review by the Employer’s Representative and shall be attached to each individual item for easy reference.

(b) The following documents are to be submitted to the Employer prior to handing over:

(i) As-built drawings for the relevant areas,

(ii) Complete inventory list,

(iii) Three sets of the Operation and Maintenance Manuals are to be provided. Such manuals shall include a full technical description with block and schematic diagrams to allow the Employer staff to operate and maintain the system equipment and components.

2 Drawings

(a) The Contractor will have to establish plans to scale and diagrams as per the following presentation:

(i) Structured Cabling Network schematic diagrams, detailed design, connection diagrams, etc.

(ii) Floor layout of each building and raceways will have to be on scale 1/100.

(iii) Equipment room layout will have to be on scale 1/50.

(iv) Racks and cabinet configuration, front and back view, as well as the plans of detail and service shafts, will have to be on scale 1/10.

(b) All Design Development drawings, Construction Drawings, and As-Built Drawings shall be submitted in hard copy format as well as in electronic format in the quantities specified below.
(c) Quantity of Submittals:
   (i) Electronic Files: 1 set.
   (ii) Reproducible hardcopies: 1 set.
   (iii) Prints: 3 sets.
16. POWER FACTOR CORRECTION CAPACITORS

16.2 PRODUCTS

16.2.1 General

Add to Clause 16.2.1 the following

4 Configuration:

(a) System includes integrally mounted, factory-wired major components including the following:
   (i) Incoming line section including main disconnect switch.
   (ii) In-rush reactor section.
   (iii) Multiple-fused capacitor banks.
   (iv) Multiple vacuum load interrupter switches.
   (v) Control cabinet.
   (vi) Power-factor meter.

Add the following new Clause

16.2.4 Performance Requirements

1 Controls permit operator to select a target power factor adjustable to any value between 1.0 and 0.80 lagging. Controls continuously sense the power factor on the circuit being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a vacuum load interrupter to switch a capacitor bank into or out of the circuit. Interrupters are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Switch only 1 capacitor bank at a time.

2 Solid-state, microprocessor-based controls include an undervoltage relay that interrupts capacitor switching for power supply interruptions longer than 15 ms. "Advance" and "Retard" push buttons on the control panel permit manual sequencing of capacitor switching.

3 Pole, Load Interrupter Switch: Rated for the repetitive high-inrush-switching duty presented by the capacitor loading.

4 Fuses for Protection of Capacitor Banks: Rated to protect interrupter, interconnecting wiring, and capacitors.

5 In-rush Limiting Reactor: Installed in capacitor circuits where required to limit switching surges to within interrupter ratings. Reactors are mechanically braced to withstand the maximum fault current to which they may be exposed.

6 Indicating lights designate energized capacitor banks.

7 Plated copper, braced to withstand the maximum fault current to which it may be exposed.
8 Enclosure Access: Hinged door with hand-operated catch. Door is interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.

9 Current Transformer: Type and configuration to suit sensing and mounting conditions.

10 Power-Factor Meter: Switchboard type, mounted in the enclosure door, with 0.5 lagging to 0.5 leading scale and accuracy of plus or minus 1 percent.

11 Main Disconnect Switch: Operable from outside the enclosure to disconnect the unit with an operating handle that can be padlocked.
17. STANDBY DIESEL GENERATOR SET

17.1 GENERAL

17.1.7 Extra Materials

1. Spare Parts: Provide manufacturer's recommended spare parts for 1000 hours operation of the plant. Provide list of manufacturer's spare parts for 2000 hours operation together with current prices. Pack with protective covering for storage and identify with labels describing contents.

2. Tools and Instruments: Provide tools and instruments required for normal routine inspection, testing, operation and general maintenance, as recommended by the manufacturer. Provide a test for tools and instruments for the Engineer's approval.

17.2 PRODUCTS

17.2.1 Diesel Generator Set

*Delete Sub-Clause 17.2.1-2(a) and replace with the following Sub-Clause*

(a) The rated output shall be as indicated on drawings, 240/415 Volts, 3-phase, 4-wire and 50 Hz. The rated output shall mean the net full derated output in Qatar at an ambient temperature up to 50°C at a relative humidity of 95%.

*Add to Sub-Clause 17.2.1-2 the following new Sub-Clause:*

(b) Performance Class: Diesel generator set is to be class G3 (15 percent) voltage drop (free drop at 100 percent loading) to ISO 8528-1 or to NFPA 110, as required by the local Civil Defence Authorities.

*Delete Sub-Clause 17.2.1-3(a) and replace with the following Sub-Clause:*

(a) The diesel engine shall be of the stationary heavy duty, turbo-charged compression/ignition, multi-cylinder 4-stroke operation. The steel base frame shall be provided with spring type vibration isolators. The engine shall be able to reach full speed within 10 seconds from start impulse and accept immediately 75% of net output (load being mixed, steady and inductive). Transient voltage variation is not to exceed 15% under any step-load application for which the system is intended, up to full rated load, recovering within +/- 2% within a few cycles. The engine construction shall be in a way to allow the dismantling of any engine component for inspection or repair without undue complication; i.e. without dismantling of other non-defective parts. The crank case shall be provided with inspection windows.

*Modify Sub-Clause 17.2.1-3(d) (iii) to the following*

(iii) The Contractor shall supply and install a cylindrical diesel oil storage tank with a capacity to operate the associated diesel generator set continuously on full load for a minimum of 7 days, unless otherwise specified in the Project Documentation.
(iv) the tank shall be welded mild steel construction suitably protected from corrosion in accordance with BS. 2594 and shall be installed in the location indicated on the drawings.

(v) The storage tank shall be complete with pipes, fittings, feed lines, vents etc. The tank shall be of the approved type located outside the diesel engine room. The tank shall be provided with 600 mm inspection manhole with cover, 50 mm filling pipe with cooped filling terminal, 50 mm air vent pipe with screen outlets, isolating valve, valved drain etc.

(vi) Electronic fuel indicator with an audio/visual alarm shall be provided for main fuel storage tank

(vii) Also the storage tank and its accessories must comply with the Qatar Civil Defence Regulations for generator installations.

Add to Sub-Clause 17.2.1-3(g) the following

(g) Provide adequate Soot filters. Contractor to submit characteristics, calculations and details for Engineer approval.

17.2.4 System Operation and Performance

Add to Clause 17.2.4 the following

6 Automatic step loading system is to be provided for sequential application of emergency loads with an adjustable (0-60 sec) time delay between each two steps. The system is to comprise all necessary control equipment including under and over voltage sensing relays, time delay relays, interface devices and wiring with respective circuit breakers. Upon starting of the plant, the “Life safety” load is to be fed as a priority. Contractor is to submit step loading schedule to the Engineer approval.

7 Contractor to ensure proper interfaces for connection to BMS. Refer to Mechanical Specifications for the monitored points via the BMS.

8 Contractor to provide a generator status indicator panel as required by NFPA. Panel to be installed inside the related Fire Command Centre.

Add Sub-Clause 17.2.7

7 Manually Operated Overhead Hoist: chain operated, self aligning, low headroom type, comprising trolley with gear mechanism combined into a compact unit, designed to run on lower flanges of I-beam runway. Hoist is to have shock resistant suspension, positive action Western type local brake; lifetime lubricated sealed bearings and load safety hook. Trolley is to have four alloy cast iron wheels. Safety factor is to be minimum of 5. Capacity of hoist is to be as indicated on the Drawings, and is to be tested to 1.5 times rated capacity.
17.3 INSTALLATION

_Delete clause 17.3.3 and replace with the following new clause:_

17.3.3 Site Quality Control

1. Equipment: Inspect equipment upon delivery to Site and report any loss or damage to the Engineer.

2. Earthing resistance tests if any are to be carried out to verify specified requirements.

3. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

4. Load tests are to be carried out at low loads to overload conditions, at various power factors. Measurements are to include voltage and frequency deviations and regulating time under various step-loading conditions, temperature measurements and pressure measurements at various locations, and in accordance with an approved plan under conditions equal to worst site ambient conditions.

5. Tests are to include:

   (a) Full load test for 8 hours continuous, immediately followed by 10 percent overload test, without interruption

   (b) Insulation measurement.

   (c) Functional tests for voltage sensing, automatic start and synchronization, transfer of load and load sharing as applicable.

   (d) Operation of engine shutdown and alarm signalling and indication, under simulated fault conditions.

   (e) Measurement of vibration transmission to building structure.

   (f) Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.

   (g) Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

   (h) Load Banks: If actual loads are not made available at time of acceptance testing, provide load banks to carry out complete test cycle of the system under loading and switching conditions necessary to prove compliance with the Specification.

   (i) Piping System: Using carbon dioxide or nitrogen from pressurized cylinder, test each system to 1.5 times normal operating pressure. Do not subject equipment, apparatus or to pressure exceeding prescribed test pressure obtained from nameplate data or from manufacturers' published data.
Apply tests before connecting piping to equipment. Remove or disconnect and blank off relief valves, instruments and devices that might be damaged by test pressure. Maintain test pressure on system for 24 hours during which time there is to be no noticeable drop in pressure. Check for leaks using soap solution. Isolate source of pressure during testing.

(j) Coordinate tests with tests for transfer switches and run them concurrently.

(k) Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

(l) Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

(m) Test instruments shall have been calibrated within the last 12 months, traceable to applicable standards, and adequate for making positive observation of test results. Make calibration records available for examination on request.
18 UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

18.1 GENERAL

18.1.1 Scope

1 This part specifies the requirements for Uninterruptible Power Supply Systems.

2 Related Parts and Sections are as follows:

This section

- Part 6 Cables and small wiring
- Part 7 Conduits
- Part 8 Trunking
- Part 9 Cable trays
- Part 10 Accessories and General Power

18.1.2 Description

1 Uninterruptible Power Supply Systems (UPS) shall be provided as specified.

2 Work shall include, but not limited to:

(a) Complete rectifier/charger-battery-inverter system with automatic static switch and maintenance by-pass circuit,

(b) Remote monitoring panel & necessary interface for data on faults/monitoring to the Building Automation and Control Systems,

(c) Interplant power and control cabling,

(d) Connection of normal a.c. power from assigned terminals/switch/circuit breaker, as shown on the Drawings,

(e) Earthing system.

18.1.3 References

1 Uninterruptible Power Supply Systems shall be provided in accordance with latest International Standards referred to therein.

18.1.4 Submissions

1 Submit full technical data of equipment for approval including, but not limited to, the following: manufacturers' catalogues, detailed description, compliance with the Standards, dimensions and weights, system operation, operating characteristics, methods of operation, protective and control provisions, heat losses, ambient conditions and limitations on electronic components etc. beyond which such components may suffer partial or permanent damage.

2 Test Certificates: submit type test and routine test certificates. System is to undergo a functional and load test program approved by the Engineer, and is to undergo a minimum 72 hours 'burn-in' test, under site simulated conditions, prior
to shipment.

3 Shop and Construction Drawings: submit drawings for approval including, but not limited to, the following:
   (a) Plans and front and side elevations, with indication of built-on control and indicating devices and instruments, exact dimensions and weights, cabling etc.
   (b) One-line diagram with ratings of each piece of equipment, cabling, grounding etc.
   (c) Control and elementary diagrams, wiring diagrams and the like,
   (d) Installation and mounting details,
   (e) Batteries arrangement and mounting details.

18.1.5 Quality Assurance

1 Installer Qualifications: UPS systems to be installed, tested and commissioned by experienced, technically trained and skilled personnel from qualified agency, certified by the manufacturer/authorized representative.

2 Local Representative: Provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy the Engineer may disqualify a manufacturer.

3 Standards: installation is to comply with relevant IEC, BS, EIA, NEMA and IEEE or equal Standards. Materials and components are to be manufacturer’s latest design, and Standards used are to be approved prior to manufacture. Radio frequency interference (RFI) suppression is to be in accordance with CISPR11 recommendations.

4 Noise Level of complete assembly is not to exceed 65 dB (A), at 1.0 m distance anywhere within UPS room.

5 Warranty: Provide 1 years warranty from date of commissioning for all equipment specified in this Section.

6 Temperature Limits within which equipment is to be designed to operate are zero to +40 deg. C at 100% rated output. Equipment is to be capable of operating under up to 55 deg. C ambient conditions with derating factor of 1.25% per deg. C over 40 deg. C.

7 Factory Tests: Design tests (type tests), special tests, and routine tests to conform to referenced standards.

8 Factory Tests Witnessing: Conduct routine tests, special tests and type tests on equipment for this Project for witnessing by Engineer. However, these special tests and type tests need not be repeated if the manufacturer submits satisfactory test reports/certificates, acceptable to the Engineer, on tests conducted previously on identical units.
9 Maintenance Contract: obtain an undertaking by the equipment manufacturer and his authorized local representative to provide an annual maintenance contract, available after substantial completion of the work, covering routine service and emergency service by trained employees, and to ensure supply of necessary standard spare parts.

18.1.6 Extra Material

1 Spare Parts: provide manufacturer's recommended spare parts for 1,000 hours operation of UPS system. Provide list of manufacturer's spare parts for 2,000 hours operation together with current prices.

2 Tools and Instruments: provide tools and instruments required for normal routine inspection, testing, operation and general maintenance, as recommended by the manufacturer.

18.2 PRODUCTS

18.2.1 General

1 Contractor shall supply, install, test and commission Uninterruptible Power Supply Systems as specified.

2 The product selected and proposed shall include manufacturer’s instructions that indicate application conditions and limitations of use stipulated by the product testing agency specified under Regulatory Requirements.

18.2.2 System Description

1 System is to be of the programmable type, microprocessor based with CPU and memory capabilities for storage of alarms, faults, status change, etc. The UPS shall permit setting parameters for the environment and type of usage to be specified by the Engineer. UPS is to be of the self-diagnostic type, equipped with a self-test function to verify correct system operation. The self test shall identify the parts of the UPS requiring repair in case of a fault. The system shall be provided with multi-password levels to limit access to software and data.

2 General: system is to be interposed between normal a.c. power supply and critical load, to secure a minimum period of continuity of no-break battery back-up for 15 minutes (for general purpose UPS) and for 1hr (for CCTV UPS) in case of failure of normal a.c. supply and maintain output voltage, frequency and phase deviation within specified tolerances.

3 System is to be non-redundant maintained (continuously supplying load through the inverter), with automatic no-break transfer to or retransfer from alternate source (bypass) in case of failure or overload on rectifier-battery-inverter system.

4 Normal a.c. Power Supply will be available from one protected source fed from either normal a.c. network or from alternate a.c. normal supply and in-house stand-by diesel generator set as shown on the Drawings. Characteristics of output of generator set and UPS system are to be coordinated for best results. Study and advise on special requirements of generator characteristic output and stability.
5 Non-Redundant System: System complete with 1 set of rectifier-battery-inverter with static and bypass switches. UPS is to be maintained (continuously supplying load through the inverters), with automatic no-break transfer to or retransfer from alternate source (bypass) in case of failure or overload on rectifier-battery-inverter system. Active harmonic filters are to be provided for each rectifier/charger unit.

6 System Overall Efficiency is not to be less than 92% at full load.

18.2.3 System Operation

1 Under Normal Conditions inverter(s) are to be synchronized and phase locked to normal a.c. supply. Upon loss of normal a.c. supply, battery is to continue supply of no-break power to inverters, which then free-run on self-generated UPS frequency reference. Upon restoration of normal a.c. supply, inverters are to re-synchronize to a.c. line, gradually (at slew rate), if frequency and voltage deviation of normal a.c. supply is within preset limits specified.

2 Automatic Transfer to Bypass: static transfer switch is to automatically transfer critical (100%) load from inverter to by-pass source (which is normal a.c. supply) if:

- Inverter output voltage characteristics fall outside specified limits,
- Critical load exceeds overload rating of UPS,
- Over-temperature is sensed,
- Manual (push button) command is given.
- Transfer to by-pass mode is to be inhibited, and an alarm initiated if voltage, frequency and/or phase shift of by-pass power is outside acceptable tolerances.

3 Re-Transfer to Inverter: re-transfer of critical load from auto by-pass source to inverter (UPS mode) is only to be possible under the following conditions:

- Inverter output voltage characteristics return to within specified tolerances,
- Original load current reduces to within rated full load capacity of UPS,
- Re-transfer selector switch is in automatic position.

4 Lock-Out Feature is to inhibit re-transfer if by-pass source conditions are outside preset tolerances or if UPS output and by-pass are not synchronized and phase locked or if UPS output is not restored to normal conditions.

5 Normal Power Restored: when normal power is restored following an outage, rectifier/charger is to initially draw no power except for transformer in-rush current. After approximately 15 seconds (walk-in time), input power requirements are to rise to power level to drive critical load and recharge battery.

6 Provide maintenance disconnecting switch fully rated to carry the full load input current of the UPS.

18.2.4 System Characteristics

1 Rectifier/charger input:
(a) Nominal input voltage : 415 V, 3-phase, 4-wire, 50 Hz
(b) Voltage input variation : +10%, -15% from nominal
(c) Frequency : +/-5% from nominal
(d) Transformer exciting current in rush : less than 600% nominal current
(e) Power factor : 0.8 lagging at full load and nominal input voltage
(f) Total harmonic feedback : maximum 5 % (total)
(g) Current limiting : 115% max. of that required to operate inverters and charge battery at full rated load, adjustment possible between 100% and 125%
(h) Walk-in current in rush : 25% to 100% FLC in 15 seconds
(i) Active Harmonic filter : to be provided

2 Rectifier/charger output:

(a) Float and equalize operation : adjustable, automatic, compatible with battery
(b) Regulation : +/-1% max. from 0-100% load
(c) Ripple load : +/-2% rms. (0 to 100% resistive load

3 Static inverters:

(a) Net system power As shown on drawings with load power output rating, nominal factor 0.7-lag to 0.9-lead
(b) Nominal output voltage 415 V a.c., 50 Hz, 3-phase,
    +/-5% of nominal : 4-wire, adjustable
(c) Output voltage regulation:
    (i) balanced load : +/- 2% (0 - 100% load)
    (ii) unbalanced load (3-phase output only) : +/- 3% (at 100% unbalance)
(d) Phase displacement (for 3-phase output system only) : 120 deg. (+/-5 deg.) at 100% load unbalance
(e) Output voltage waveform : 5% max. total harmonic
    3% max. single harmonic
(f) Frequency stability: normally synchronized to input line frequency over +/- 10% adjustable range; free running at +/-0.5% over full battery.

1.2.2 Voltage variation, load and p.f. range; slew rate not to exceed 0.1 Hz/sec.

(g) Dynamic output voltage +/- 10% max. recovering tolerance sudden full load removal application or to within 1% in less than 100 milliseconds.

(h) Over-load rating: 125% for 10 minutes 150% for 60 seconds 1000% for 5 cycles 105% continuous.

4 Automatic static transfer switch:

(a) Transfer time: 150 micro-second (overlapping) maximum.

(b) Total sensing and transfer/retransfer time: 2 milliseconds, maximum.

(c) Retransfer mode: automatic/inhibit (selectable).

(d) Retransfer delay: 2 - 32 sec. in auto mode (selectable).

(e) Transfer point (adjustable): +/-10% of nominal output voltage.

(f) Retransfer point: +/-5% of nominal output voltage (adjustable).

(g) Transfer inhibit point: +/-20% of nominal output voltage (adjustable).

18.2.5 Components and Accessories

1 Materials and Parts: electronic devices are to be solid state, hermetically sealed. Indicator lights are to be twin LED type, those denoting blown fuse conditions are to be seen by operator without removing panels or opening cabinet doors. Power connections and remote alarm and control wiring are to be accessible at terminal boards. Power semi-conductors are to be fused. Metal surfaces including copper and aluminium heat sinks and busbars are to be treated with permanent protective coating. Electro-mechanical power devices and relays are to be vacuum impregnated, insulated for maximum operating voltage conditions, and enclosed in dust-tight enclosures. Cables are to be fire resistant high temperature grade.
2 UPS is to be provided with a socket connection for a serial interface to be linked to a portable PC, to a modem or to the BMS system for communication with the UPS. It shall enable interrogation of the UPS about status, faults, data stored, reprogramming, etc.

3 Housing: equipment is to be housed in a free-standing, well ventilated, totally enclosed modular assembly with front accessible lockable doors, giving easy access for maintenance, inspection and adjustments, and with provisions for handling and lifting during and after installation. Enclosures are to be suitable for industrial, tropical environments; protection IP 21 to IEC 60947-1 and IEC 60529, of galvanized sheet steel construction treated against corrosion and with light grey RAL7032 baked paint or epoxy finish to approved standard.

4 Sub-Assemblies and components are to be mounted on pull-out and/or swing-out trays, of the plug-in type where possible. Where it is not possible to mount components in pull-out or swing-out trays, they are to be easily accessible inside the enclosure. Assemblies shall be replaceable without requiring any adjustments or settings in the UPS.

5 Ventilation: an integral, forced-air, cooling system is to be provided in each UPS module to remove dissipated heat efficiently, and ensure components operate within environmental ratings. Air is to enter bottom of cabinet through replaceable filters, and exhaust through the top. At least two fans are to be provided for ventilating each enclosure. No degradation of performance is to occur in the event of a single fan failure. Temperature sensors, mounted on semiconductor heat sinks, are to initiate alarm if maximum working temperature is exceeded.

6 Rectifier/Charger Unit is to have mainline circuit breaker and two-winding dry-type, Class H insulated, class B temperature rise, with metallic electrostatic shielding, high efficiency (98%), regulating transformer and is to be automatic with soft start-up (walk-in) feature, using silicon controlled rectifiers (thyristors) with control logic circuitry to control firing angles to thyristors to suit power output requirements and protect against primary power surges, lightning transients, under-voltage and over-voltage conditions. Output is to be passed through LC filters to d.c. bus.

7 Rectifier/Charger Unit is to be capable of supplying full load power to inverter, and to charge the battery from a discharge condition to 95% charge within ten times discharge period, and maintain full charge at floating voltage until next operation. Charger current is to be voltage regulated and current limited. Where three-phase supply is involved, rectifier is to be at least 12-pulse type.

8 Inverter is to employ Insulated Gate Bipolar Transistors (IGBT) technology in three-leg, pulse width modulation (PWM) design with high frequency switching technique, and complete with output transformer and filters. Inverter start-up is to be automatic, to reach full voltage within milliseconds and deliver power to the load within 2 seconds. Inverter is to start at any load including short-circuit. Output transformer is to be two-winding dry-type, Class H insulated, class B temperature rise, with metallic electrostatic shielding, high efficiency (98%).

9 Inverter Oscillator is to operate and maintain output frequency of inverter within specified tolerances, and be capable of synchronization and phase-locking to normal power supply frequency. When inverter is phase-locked to normal power...
supply, and latter fails, oscillator is to automatically revert to free running state (quartz oscillator) and maintain specified limits.

10 Automatic Static Transfer Switch is to be continuously rated at full load (100% FL), hybrid type (make-before-break), solid state transfer device with logic thyristor assembly isolatable or completely withdrawable for maintenance. When signal to close switch is initiated, thyristors are to instantaneously conduct power to prevent deviations and breaks in load voltage outside specified tolerances.

11 Maintenance By-Pass Switching: manual (make-before-break) by-pass switch is to allow load to be transferred to by-pass source without interruption of output, and provide isolation of UPS and static switch during maintenance. Test position is to permit testing of static switch while load is being fed from bypass power circuit. Transfer inhibited warning circuit is to be provided to give an alarm indication in case by-pass supply is beyond acceptable tolerances.

12 Protection: UPS modules are to have built-in or inherent electronic current-limiting protection against permanent self damage effective down to short-circuits. Fast acting, current limiting devices are to protect against failure of any solid state component. Internal failure in any UPS module is to cause immediate isolation from input and output by operation of static interrupters or causing shut down of faulty module. Protection is to be provided against, but is not limited to, the following:

(a) Input over and under voltage and power line surges,
(b) Output over voltage and voltage surges,
(c) Sudden abnormal changes in output load conditions,
(d) Short-circuits at output terminals,
(e) Inverter and rectifier overcurrent,
(f) Auxiliary control circuit overcurrent.

13 UPS Output Neutral: is to be designed to continuously carry twice the full load phase current.

14 Input Filter Disconnection: UPS control system is to disconnect the input filters in case of interruption of utility power supply failure while the UPS is operating at light loads (less than 25%).

15 Battery: As specified in the Project Documentation, the batteries shall be either sealed nickel cadmium or valve regulated acid), all maintenance free type high rate discharge, heavy duty, and sized for the pre-selected time with the UPS operating at rated load. Electrolyte specific gravity is not to exceed 1.25 when fully charged at 25 deg. C. Ampere-hour rating is to be sufficient for emergency period specified with all inverters operating at full rated output, to a discharge limit of not less than 1.65 V per cell. Cells are to be normally maintained at 2.25 V per cell. Guaranteed life is not to be less than 10 years, with a capacity drop down to not less than 80% under normal expected service.

16 Battery Cabinets: The battery enclosure shall match style and appearance of the UPS enclosure, and shall be designed to be installed adjacent to the UPS. It shall be of steel construction, with plastic insulating rails at points of contact with battery cases. Racks are to be painted with electrolyte resistant paint, are to be of
appropriate design for space in which installed, and directly accessible for
maintenance. Cables are to be rubber insulated electrolyte resistant type. The
cabinet shall be provided with a temperature sensor and connected to the
charger in order to control the battery current according to temperature.

17 Batteries Monitoring System: A battery monitoring system shall be provided with
at least the following key features:

(a) Monitoring of batteries key parameters: system voltage, float, charge and
discharge current, ambient and pilot cell temperatures, etc.
(b) Programmed cell impedance measurement,
(c) Battery discharge data logging,
(d) Programmable test and out-of-limits alarms,
(e) Complete isolation from battery string,
(f) Third-party software integration over TCP/IP,
(g) User configurable dry contact alarms,
(h) Software shall be “Windows” based software to operate on Windows XP.

18 Mimic Panel: UPS assembly is to include a mimic diagram with digital and LED
displays, indicating instruments and control devices, in true relative positions.

19 Local Panel Instruments are to include at least the following (digital readings):

(a) Inverter input voltmeter, measuring d.c. bus volts,
(b) Battery ammeter, measuring charge/ discharge current,
(c) A.C. voltmeter to measure inverter output voltage, normal supply voltage or
system output,
(d) UPS output ammeter and frequency meter.

20 Local Panel Indicators are to include at least the following:

(a) System on battery supply,
(b) Inverter phase locked to verify synchronization between inverter output and
normal a.c. supply input,
(c) Static switch on normal a.c. supply (bypass mode),
(d) Static switch inhibited,
(e) Over-temperature, indicating excessive temperature in heat sinks for
transformers, rectifier/charger and inverter (alarm to automatically transfer
load to by-pass circuit),
(f) Inverter output overload, indicating inverter output beyond specified
rating failure of any stage, d.c. bus earth fault, and inverter output earth
fault.

21 Local Built-In Controls are to include at least the following:

(a) Inverter on/off,
(b) Battery input circuit breaker,
(c) Auto/manual reset-test switch,
(d) Manual reset switch,
(e) Hybrid switch transfer test push-button,
(f) Re-transfer auto/inhibit selector switch to allow automatic re-transfer of load to inverter after timed interval of normal operation and inhibit re-transfer of load to inverter until hybrid switch is in auto-mode,
(g) Battery automatic/equalize recharge timer, 0 - 30 hours adjustable, with automatic/boost/equalize switch (accessible to maintenance personnel only and to be used only with manufacturer’s recommendation for type of battery specified),
(h) Voltage and frequency adjustment controls with locking devices (accessible to maintenance personnel only),
(i) Indicator test/reset switch,
(j) Control power supply isolator (accessible to maintenance personnel only),
(k) Alarm test-accept-reset.

22 Local Built-In Alarms causing horn to sound, with tripping command if required, are to include at least the following:

(a) Fan failure: alarm only,
(b) Over temperature: alarm with automatic transfer of load to by-pass after a safe preset period,
(c) D.C. volts out of limits: alarm with indication,
(d) Fuse failure: alarm,
(e) Battery on load/disconnected: alarm only,
(f) Overloads: alarm only with a trip command if prolonged, for each rectifier/inverter unit,
(g) Normal a.c. supply failure: alarm only,
(h) Hybrid switch operation to by-pass mode: alarm only,
(i) Low and high output voltage: alarm only.

23 Remote Panel Control and Indicators are to include at least the following:

(a) Audible alarm to sound for any alarm condition,
(b) LED indicators for mains power available,
(c) By-pass source available,
(d) Inverter a.c. output available,
(e) Inverter synchronized and phase locked,
(f) Critical load connected to inverter,
(g) Critical load connected to by-pass source,
(h) Hybrid transfer switch inhibited,
(i) High/low d.c. voltage,
(j) Over-temperature,
(k) Inverter output overload,
(l) Alarm-indicator switch,
(m) Emergency system shut-down push-button,
(n) Silence / test / reset switch.

18.3 INSTALLATION

18.3.1 General

1 Equipment Bases: ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturers' drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

2 Built-In Items: ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which are to be built into concrete foundations, bases or building structure are provided as and when required and that they are properly installed.

3 Tools: use only tools recommended by equipment manufacturers for installations, particularly in making connections and adjustments.

4 Earthing: provide direct interference free earthing circuit in accordance with Part 22 of the Specification.

5 Supervision: carry out equipment installation under the direct supervision of a qualified technician, licensed by and trained at the factory. Final adjustments and putting into satisfactory operation are to be made by a specialist delegated by the factory.

18.3.2 Tests on Site

1 Power Supply Output Disturbance: provide microprocessor based instrument, and monitor and record power supply output disturbance of voltage and frequency. Instrument details are to be submitted for approval.

2 Test Periods are to be prolonged (over 24 hours) and as requested by the Engineer, to verify and obtain realistic voltage and frequency profile under any loading and switching conditions within the criteria specified.

3 Data Logging is to include high and low average voltage, sags and surges, spikes and spike bursts, drop-outs, high and low frequencies etc. with print-out and storage on cassette tape for subsequent re-entry into instrument's memory for display or print-out.

4 Tests are to include loads at various power factors from low-load to overload condition, and measurements of temperature, heat losses, output voltage, wave shape, and harmonic content and frequency stability.

18.3.3 Cleaning

1 On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match
original finish. Clean components internally using methods and materials recommended by manufacturer.

18.3.4 Demonstration and Training

1 Train Employer’s maintenance personnel to adjust, operate, and maintain the system installation.
20. ELEVATORS

20.1 GENERAL

20.1.1 Related Documents

1. The work of this part is integral with the whole Project Documentation and is not intended to be interpreted outside that Contract.

2. Coordinate the Work with all other services affecting the work of this Part.

20.1.2 Summary

1. This Section includes the following:
   
   (a) Electric traction passenger elevators.
   
   (b) Electric traction service elevators.

20.1.3 Definitions

1. The following terms used on Drawings and in the Specification are synonymous and may be used interchangeably:
   
   (a) "Elevator" and "Lift".

2. Electric Traction Elevators: Elevators in which cars are hoisted by wire ropes using electrically driven traction sheaves and are defined to include driving machines; cars; hoistway doors; guide rails; guide-rail brackets; roping; buffers; counterweights; signals; control systems; electrical wiring within elevator system; and devices for operations, safety, security, required performance at rated speed and capacity, and for complete elevator installation.

3. Defective Elevator Work: Operation or control system failures; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

20.1.4 SUBMITTALS

1. Submittals: Refer to part 1 and other parts, for submission of documents, presentation and number of copies.

2. Product Data: (For each elevator): Include rated capacities, sizes, performances, operations, safety features, finishes, and similar information including car design and layout, hoistway door and frame details, etc.
   
   (a) Detailed conformity (Deviation statement) to required standards, specifications and schedules, to be submitted at tendering phase.
   
   (b) Guarantees on power and spare parts requirements.
   
   (c) Sample Warranty: Copy of manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.
3 Shop Drawings: (For each elevator): Coordinate with elevator supplier for exact shaft dimensions and notify the Engineer in case of any discrepancy with available data. Show plans, elevations, sections, and large-scale details indicating service at each landing, equipment layout in shaft, machine room layout – as applicable, coordination with building structure (ventilation openings, sleeves / openings, etc), and relationships with other construction (rail bracket spacing, structural supports, maximum dynamic and static loads imposed on guide rails requiring transfer to building structure at points of support, load on hoisting beams, etc.). Indicate variations from specified requirements and locations of equipment and signals. Include maximum and average power demands.

4 Construction work shall not proceed until final approval of material/equipment and Shop drawings obtained.

5 Samples: For exposed finishes for car, hoistway doors, and signal equipment; 2500 mm square samples of sheet materials; and 250 mm lengths of running trim members.

6 Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of similar completed projects with project names and addresses, names and addresses of architects/engineers and employers, and other information specified or required by the Engineer.

7 Maintenance Manuals: For each electric traction elevator, including operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include all diagnostic and repair information available to manufacturer's and Installer's maintenance personnel. Submit for the Employer’s information at project closeout. Refer also to the requirements of Section 7 of EN 81-70.

8 Declaration of Conformity to EN 81-70 shall be provided to the Employer, for each elevator.

9 Warranties: Warranties specified in this Section.

10 Inspection and acceptance certificates and operating permits as required by governing authorities for normal, unrestricted elevator use. Submit to Employer at project closeout. (Refer also to section 16 of EN 81-1).

11 As-Built Drawings: At project closeout, submit record drawings of installed elevators, in accordance with requirements of the Project Documents.

12 All above submittals including software programs shall be in English Language only.

20.1.5 QUALITY ASSURANCE

1 Installer Qualifications: Engage the elevator manufacturer or an experienced Installer approved by the elevator manufacturer who has completed elevator installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

2 Regulatory and Safety Requirements: In addition to local governing regulations,
comply with the applicable provisions of the latest edition of the following standards, referred to as the "Code", in order of priority:

(a) EN 81: "Safety Rules for the Construction and Installation of Lifts" and its related derivatives.

(b) All normative references listed in EN 81-1 Standard. These include those issued by ISO, IEC, CEN and CENELEC and any other standard referred to.

(c) “Accessibility to lifts for persons including persons with Disability” EN 81-70 regarding the use of elevators by disabled people.

(d) Power supply and electrical installations shall conform to the local power authority practices - QGEWC specifications.

(e) All electric power installations shall comply with the "IEE Wiring Regulations" where not in contradiction with QGEWC requirements.

(f) Electromagnetic compatibility (EMC): EN 12015 (emission) and EN 12016 (immunity).

(g) Nominal characteristics of all equipment forming part of the electrical works shall be specified to conform to the relevant International Electro-technical Commission (IEC) Standards and the International Standards Organization (ISO).

(h) Comply with code requirements for seismic risk classification, as per UBC code.

(i) "American with Disabilities Act – Accessibility Guidelines for Buildings and Facilities" issued by the "American Society for Hospital Engineering" where not in contradiction with EN 81-70 requirements.

(j) ASME A17.1, "Safety Code for Elevators and Escalators" for life safety requirements, where not in contradiction with EN 81 requirements.

3 Conformity to Standards: Contractor shall be responsible for the provision of a complete installation in total conformity with the Standards. It is the Contractor’s responsibility to provide all Standards requirements even if not accounted for in this Specification and to coordinate with the Engineer on the issues related to the safety of the installations.

4 In the event of a conflict between any of the above applicable or reference Standards, the more stringent requirements shall take precedence.

5 In case Contractor proposes part of equipment in accordance with other Standards, then detailed comparison documents including one original copy (in English – translation to English should be the approved one by the Standard originating Committee) of the latest edition of the referred to Standard (and related annexes) are to be submitted for Engineer's approval. These documents shall detail discrepancies and advantages of offer. Submittals shall be preceded by a written approval of the Engineer on such. However, the Employer and the Engineer reserves the right to accept or reject such proposals.

6 Mean Time between Failures (MTBF) shall not exceed one failure per year. This time shall be considered for corrective maintenance and not preventive.
20.1.6 PROTECTION

1. Temporary Use: Do not use system for construction purposes. However, in case it is required by the Engineer and/or the Employer, adequate temporary protections are to be provided by the Contractor.

2. Provide full maintenance service by skilled, competent employees for equipment used for construction purposes. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Use parts and supplies as used in the manufacture and installation of original equipment.

3. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevators. If, despite such protection, elevators become damaged, restore damaged work so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required. Repair shall be done to the satisfaction of the Engineer and at no extra cost to the Employer.

4. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that insure elevators are without damage or deterioration at the time of Substantial Completion.

20.1.7 CLIMATIC CONDITIONS

1. All electrical equipment, apparatus, materials, and accessories shall be designed, specified and de-rated for a continuous and trouble free operation in the ambient conditions specified within Section 21.

2. Equipment, apparatus, material and accessories are to be corrosion and salinity proof. All equipment are to have ratings suitable for 50 deg. C indoor ambient. Solid-state equipment shall withstand at least 40 deg. C.

20.1.8 DELIVERY, STORAGE AND HANDLING

1. Packing and Shipping: Deliver materials, components and equipment in original protective shipping containers with labels intact and legible.

2. Delivery on Site: Do not deliver materials, components and equipment on site until adequate protected storage facilities are available or for direct installation.

3. Storage and Protection: Store materials, components and equipment above ground, under cover and in a well-ventilated protected area. Comply with manufacturer’s recommendations concerning temperature and relative humidity limitations during storage.

20.1.9 WARRANTY

1. Manufacturer’s Warranty: Provide a written warranty signed by the elevator manufacturer agreeing to repair, restore, or replace defective elevator work within the specified warranty period. Spare parts required under related Article hereunder are not part of this requirement.

   (a) Warranty Period: 12 months from date of Substantial Completion.
20.1.10 MAINTENANCE SERVICE

1 Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months’ full maintenance service by skilled, competent employees of the elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Use parts and supplies as used in the manufacture and installation of original equipment. Maintenance schedules are to be established by the Contractor and submitted for approval. Spare parts required under Article 2.12 are not part of this requirement.

   (a) Include 24-hour-per-day, 7-day-per-week emergency call-back service.

        (i) Response Time: A stand by team shall be available at site to attend emergency callbacks immediately.

20.2 PRODUCTS

20.2.1 DESCRIPTION

1 Components are to be designed in accordance with usual engineering practice and calculation codes, taking into account all failure modes considered in the Code. These are to be of sound mechanical and electrical construction and made of materials, free of defects, with adequate strength and of suitable quality. Materials classified as harmful are not to be used.

2 Components are to be selected and installed to suit the environmental conditions and influences in order not to affect the safe operation of the system

20.2.2 MACHINE AND DRIVE

1 All the lifts are machine roomless. The machine-drive shall be of the latest market proven, state of the art and high-efficiency. Motor shall be enclosed, ventilated type. Bearings shall be of the appropriate type, properly lubricated, of ample capacity to sustain loads supported by machine and rigidly mounted in proper alignment. Other types of motors with successful history in the last years (like the Permanent Magnet Synchronous Motors) may be proposed. Motors' characteristics and performance, including energy consumption profiles, are also to be detailed. Low energy consumption shall be considered as an advantage.

2 Gearless Machine-Bearings: Sleeve or anti-friction type, properly lubricated, of ample capacity to sustain heavy loads supported by machine, and rigidly mounted in proper alignment. Sleeve bearings are to have automatic lubrication.

3 Gearless Machine-Brake: Spring applied, magnetically released, self-cooling and capable of holding car securely under maximum speed and load conditions. Brake is to be designed for automatic and instantaneous application immediately after power is interrupted on motor. Brake springs are to work in compression.

4 Gearless Machine-Manual Brake Release: Provide means for manual release of brakes, to allow for rescue in emergencies. Instructions for use under emergency conditions are to be submitted to the Employer, along with instructions for use. Brake emergency release is to be self-resetting.

5 AC Electric Motor: Induction type; shall be reversible, wound for specified
voltage, specifically designed for elevator service, to sustain continuous operation in maximum ambient temperature specified, and with number of starts indicated in Schedule No. 1 of “Elevators Schedule” Article. Motor is to be self-ventilating, with high starting torque and low starting current.

6 Variable Speed AC Motor: Induction type, 3-phase, reversible, with electronically controlled speed, using controlled semi-conductor power rectifiers (IGBT transistors controlled) in main circuit and solid-state electronically computed acceleration and deceleration equipment in control circuits. Speed measurement and feed back control are to be through a tacho-generator mounted on the machine, measuring actual revolutions of drive and comparing with programmed reference level. Deceleration is to be electronically controlled by eddy-current braking, feeding motor winding with thyristor controlled DC current. Acceleration and deceleration are not to exceed 1 m/s/s and should be designed to eliminate any jerk movement.

7 Motor drive unit controlling the motor speed shall be capable of keeping the elevator service under the conditions specified in “Electrical Equipment” Article. Drive unit power factor to exceed 0.9.

8 Machine Motor Assembly: to be one unit assembly mounted on common bedplate. Assembly is to be adequately isolated from main building structure by rubber or other approved material, to prevent transmission of noise and vibration. Motor insulation Class shall read F, Duty S1 and IP 55.

9 Motor Rating: It is the contractor’s responsibility, and in accordance with the Standards requirements, to provide and install, for each elevator, the motor drive properly sized and suitable to lift the required rated passengers’ capacity in addition to the specified car dimensions, structure, finishes, etc. The Engineer is to be informed about any discrepancy at the Tender stage.

10 Elevator Capacity: It is the contractor’s responsibility, and in accordance with the specified car dimensions to provide the related capacity in accordance with the requirements of standards. The capacity of the elevators mentioned in the schedules is nominal and reflects the required transport capacity. The Engineer is to be informed about any discrepancy at the Tender stage.

11 Lifting Tackle: Provide and fix steel joists of adequate strength in shaft for lifting car, counterweight, motor and controller, etc. depending on type of traction equipment, as appropriate.

12 Traction and Deflection Sheaves: Traction sheave is to be fine grained cast iron of suitable hardness, accurately grooved for number and size of hoisting ropes, and is to give constant traction and long rope life. Bearings for sheaves are to be approved type. Diameter of sheave is to be not less than forty times overall diameter of ropes. Deflection and secondary sheaves are to be of same material and are to be protected by guards extending below machine level, when required.

13 Automatic Levelling: Maximum tolerance ± 3 mm for variable speed elevators. Accuracy is to be maintained regardless of change of load or rope stretch.

20.2.3 Car

1 Construction: Refer to schedules and drawings. Materials are to be fire resisting.
Car characteristics shall be mainly provided in accordance with the requirements of EN 81-1, particularly Section 8 and related Annexes. Entire operation of the car shall be “noise free”.

2 Reinforce roof to sustain 150-kg load on any 0.2 m2, and 50 kg at any point. Provide trap door at least 500 x 600 mm, opening outward and capable of being opened from both sides. Opening of trap is to activate electrical interlock preventing operation of elevator.

3 Platform: Fill frame with timber sub-floor and provide specified top floor finish. Protect underside of platform with sheet steel covering, at least 1.5 mm thick. Sill is to be anti-slip, with provision for car doors. Sill shall be of the type reducing the number of call-backs related to entrance problems.

4 Load Weighing Device: Built into floor or under the floor.

5 Isolating Cushion: Rubber pads supported on auxiliary steel frame fastened to car frame are to form isolating cushion between car and car frame.

6 Guide Devices: Adjustable and renewable, and fastened to top and bottom of car frame.

7 Buffer rails and kick plates fitted to car are to be not less than 75 mm and 150 mm wide respectively.

8 Ventilation and Lighting: Provide each car with necessary lighting (illumination level: 200 Lux) and adequately rated, silent running, properly padded and rigidly fixed exhaust fan of approved type and manufacture. Lighting and false ceiling types to be approved by the Engineer in accordance with I.D requirements.

9 Fan and lights are to switch on automatically when car is called or when landing doors are opened, remain switched on whilst car is in operation, and switch off by time relay 180 - 240 seconds after car has stopped. Lighting level is to be minimum 200 Lux. Lighting fixtures shall be provided with heat-tempered safety glass.

10 Natural ventilation is to be provided for each car irrespective of provision of forced ventilation or air conditioning.

11 Inspection lamp sockets are to be provided inside, on roof and below car.

12 Indicators and control stations are to be provided in each car according to “Control Accessories” Article.

13 Equipment on top of the car is to be provided in accordance with Section 8.15 of EN 81-1. A retractable balustrade shall be provided on top of the car to insure safety of maintenance personnel on top of car.

14 Intercom Set: Provide hot-line intercom set integrated in car control panel. Communication shall be established with the security room, lift machine room, and the building reception. Cables are to be fire rated.

15 Padded Covers: Provide one set with each type of elevator, to protect car finishes from damage at times elevator is used to carry freight. Provide hooks for hanging padded covers.
16 Identification: all elevators are to be provided with internal identification number (min. 75 mm letter height) at top and bottom. Numbering to be approved by the Employer/Engineer.

20.2.4 Auxiliaries

1 Guide Rails: Highest quality steel T-sections, suitable for travel, car weight and support locations at structural floors and connected with steel splice plates. Guide surfaces are to be accurately machined and polished. Guide rail fixings are to be heavy steel brackets with clips that allow guide rail movement. Guide rail and fixings are to withstand sudden application of safety gear under maximum load. It is the Contractor's responsibility to provide exact/suitable support system, fixing accessories and distances. Means are to be provided to absorb rail expansion and structural settlement.

2 Guide shoes shall be provided and mounted to the top and bottom of both the car and counterweight frame. Each guide shoe assembly shall be arranged to maintain constant contact on the rail surfaces.

3 Counterweight: Structural steel frame fitted with cast iron sub-weights secured with tie rods or steel sub-weights secured with clamps to prevent movement. Weight is to equal total car weight plus 40 to 50% of contract load. Counterweight is to be screened to a height of 2.5 m from bottom of pit and fitted with renewable guide shoes at top and bottom. All counterweights are to be provided with safety gear.

4 Suspension Ropes: Special acid quality steel or high-grade traction steel with safety factor as specified in the acceptable Standard. Ropes are to be securely attached to car and counterweight and are to have independent means of adjustment. The number and size of ropes shall comply with the factor of safety requirements of EN 81-1. Provide test certificates of compliance with appropriate Code and/or Standard prior to shipment.

5 Safety Gear and Governor: Mechanical safety gear is to be mounted on and securely fastened to car frame and actuated by a governor mounted in machine room. Governor is to be directly driven by steel cable or chain.

6 Safety gear is to hold car securely under maximum load and governor tripping speed conditions. Jaws of gear are to engage guide rails through self-aligning shoes with surfaces carefully machined parallel to guide rail face. Pressure of jaws on the two guides is to be equal. Safety gear is to bring car to stop from governor tripping speed. Method of stopping is to be instantaneous or progressive as specified in Elevator Schedule. Deceleration is to be inferior to gravity.

7 Governor is to be accurately adjusted and sealed to electrically trip safety gear at a speed at least equal to 115% of car's specified speed. The maximum allowable tripping speed shall be as specified in EN 81-1. Operation of governor on over speed is also to open a switch disconnecting power from motor and brake control circuits, which are to be open before safety gear is applied. Restoration of power is not to be possible until safety gear has been manually re-set. Mechanical tripping will appear at about 1.2 to 1.3 times the rated speed. Double trip (downward and upward) protection to be in accordance with EN 81-1. Required related type tests certificates are to be submitted.
8 Buffers: To approved design, as specified in “Elevators Schedule”, and installed under each car and counterweight.

9 Compensation: Whisper Flex cables shall be used. Anti-rebound devices shall be provided as per EN 81-1.

10 Pit Ladder: Provide fixed vertical steel ladder to pit extending a minimum of 1m above sill of bottom terminal entrance and constructed of hot dip galvanized steel. Ladder rungs to be a minimum of 400 mm wide and spaced 300 mm on centre.

11 All safety factors are to be applied in accordance with the applicable Standards recommendations.

12 Above auxiliaries shall be designed and coordinated with the Engineer in order to provide an aesthetically pleasant appearance.

13 All civil works required by the standards inside shafts (dividing beams, etc.), inside machine room (beams to support pulleys, etc.) and inside pits (safety screens, pulleys supports, buffer pads, etc.) shall be included in this scope of work.

20.2.5 Doors

1 Opening Sizes: Landing and car door openings are to be same size.

2 Car and landing doors' characteristics shall follow the requirements of the schedules in addition to clauses 7 and 8 of EN 81. However, measures leading to minimize the door loss-time due to creeping shall be considered as an advantage.

3 Door Operator Equipment:

(a) Door Operator: A VVVF operated door operator with or without reduction gear shall be provided to open and close the car and hoistway doors simultaneously. Door movement shall be cushioned at both limits of travel. An electro-mechanical interlock shall be provided at each hoistway entrance to prevent operation of the elevator unless all doors are closed and locked. An electric contact shall be provided on the car at each car entrance to prevent the operation of the elevator unless the car door is closed.

(b) The door operator shall be arranged so that, in case of interruption or failure of electric power, the doors can be readily opened by hand from within the car, in accordance with applicable code. Emergency devices and keys for opening doors from the landing shall be provided as required by the local code.

(c) Doors shall open automatically when the car has arrived at or is leveling at the respective landings. Doors shall close after a predetermined time interval or immediately upon pressing of a car button. A door open button shall be provided in the car. Momentary pressing of this button shall reopen the doors and reset the time interval.

(d) The car door shall be provided with a protective curtain of light from which the active part extends at least 2.0 m above the floor. This device shall be
designed to sense an obstruction in its path while the doors are closing and automatically cause the car and hoistway door to return to the open position before touching the obstruction. Additional mechanical protection shall be provided.

(e) Door hangers and tracks shall be provided for each car and hoistway door. Tracks shall be contoured to match the hanger sheaves. The hangers shall be designed for power operation with provisions for vertical and lateral adjustment. Hanger sheaves shall have polyurethane tires and pre-lubricated and sealed-for-life bearings.

(f) The maximum kinetic energy shall be in accordance with EN 81-1 recommendations.

4 Door Frames and Sills: Door support units, fitted at landing entrance, are to be self-contained, comprising sill, two angle uprights and head. Non-slip sill is to be fitted at each landing and car entrance. Sills must have slots to allow debris to fall out in order to prevent jamming of the doors.

5 Contractor is to coordinate with the Engineer regarding landing door installation details.

6 Doors shall be 1.5 hours fire rated. Test certificates, from an approved laboratory, are to be provided for approval

20.2.6 Controller

1 Enclosure: Vertical, totally enclosed cubicle type, constructed from sheet steel, with hinged doors at front and ventilation louvers or other approved method to ensure that inside temperature does not exceed safe limit for equipment. IP 20.

2 Components are to include all contactors, relays, logic circuits, selectors, timing devices, control transformers and apparatus associated with control of elevator in machine room. Disconnecting devices may be wall mounted outside controller cubicle, next to main supply feeder. Characteristics are to be in line with standard specifications, Section 21.

3 Contactors: Power contactors are to be electro-magnetically operated and are to have carbon to copper contacts. Control circuits are to have silver contacts. Contactors are to close with wiping, self-cleaning action. Reversing contactors are to be mechanically interlocked to prevent contacts for one direction closing whilst contacts for other direction are closed. Duty shall be for elevators’ application in accordance with IEC 947-4 recommendations.

4 Insulation for coils and other insulated components is to be Class B or better, suitable for ambient temperatures at location.

5 Control Voltage to be equal or less than 50 V AC.

6 Protection: Controller is to provide protection, by cutting-off power supply, applying brake and bringing car to rest, in the event of any of the following failures:

   (a) No voltage or sustained under voltage.
   (b) Over-current in any component.
(c) Phase reversal of power supply.

(d) Overload.

(e) Operation of any safety device.

(f) Overheating of electronic components.

(g) Any other protection required by the applicable standards.

7 Interface with BMS: each equipment shall be provided with additional free contact points required for direct interfacing with the BMS. These shall read for, at least:

(a) Run / Stop / Fault,

(b) Safety circuit interruption,

(c) Controller fault alarms,

(d) Fire emergency,

(e) Healthy operation,

(f) General Alarm,

(g) Cabin Emergency call alarm,

(h) Confirmation of fire mode operation,

(i) Healthy status of Automatic Landing System,

(j) Healthy status of Auxiliary Emergency Supply,

(k) Other requirements mentioned in these specifications.

Provide 25% spare contacts capacity for additional future requirements.

8 It is the contractor’s responsibility to ensure proper interfacing, through the provision of dedicated interfaces, after coordination with the BMS contractor.

20.2.7 Electrical Equipment

1 Auxiliary Emergency Supply: Control system is to operate from rectified AC supply, at a suitably selected and approved DC voltage. Negative terminal is to be connected to earth. Battery is to be capable of operating all controls, car fan, lights and alarm circuits for 6 hours, in the event of power failure. Unit to include solid-state charger and testing means enclosed in a common enclosure. Battery shall be of the rechargeable sealed lead acid or nickel cadmium with 10-year minimum life expectancy, at site conditions. Auxiliary Emergency Supply healthy status shall be monitored by the BMS. The Contractor shall coordinate with all concerned parties for the provision of required connections and / or interfaces.

2 Emergency Power Automatic Landing System: System operates to rescue passengers at the time of unexpected power failure. System controls the elevator car to land at the nearest floor and opens doors immediately in order to evacuate passengers. Operation shall be automatic. All safety features shall remain operational during system operation. After passengers’ evacuation doors will remain closed and elevator stopped. Emergency Power Automatic Landing System healthy status shall be monitored by the BMS. The Contractor shall coordinate with all concerned parties for the provision of required connections and / or interfaces.
3 Seismic Operation Control System with Primary wave Sensor: The device is sensitive to the primary wave of the earthquake. Upon detecting such wave, the equipment will direct the cars to the nearest landing and immediately open doors for quick and safe exit. Doors will close after a predetermined time. Seismic detectors are included in this scope of work.

4 General:

(a) Provide all wiring for proper operation and control of equipment in accordance with electrical Specifications and applicable Codes. Provide wiring for communications facilities and connection to the various related low current systems and building management system.

(b) Pit shall be equipped in accordance with EN 81-1 requirements.

5 Electrical Wiring Characteristics:

(a) Equipment generally is to be in accordance with the requirements of the relevant local and international Codes and Standards. Equipment is to operate satisfactorily if voltage varies +/-10% and/or frequency varies +/-6% from nominal.

(b) Electric installations and appliances are to satisfy Section 13 of EN 81-1, QGEWC standard specifications and section 16050 in particular.

(c) Protection against electric faults shall be provided in accordance with the requirements of Section 14 of EN 81-1 and local codes.

(d) Stopping Devices shall be provided in accordance with Clause 14.2.2 of EN 81-1.

(e) Wires and cables: are to be low smoke and halogen-free type (LS0H). Colour coding, numbering and ferruling to be in accordance with the requirements of QGEWC standard specifications.

(f) Conduits and Wireways: wiring and unarmoured cables, except those moving with car, are to be enclosed in heavy gauge galvanized steel conduits or wireways. Identification shall be in accordance with QGEWC standards and section 16050 in particular.

(g) Wiring is to be arranged neatly and clearly in conduits, and terminated on shrouded terminal blocks.

(h) Electrical Enclosures and Boxes: shall be galvanized sheet metal duly painted as per QGEWC standard specifications.

(i) Spare capacity: provide 20% spare conductors and wires for each elevator.

(j) Grounding: metal frames of lift installations are to be earthed in accordance with the relevant Codes and Standards.

20.2.8 Control Accessories

1 General: Provide all necessary cars; landing and other control accessories as required by specified control system and in accordance with the standards requirements and especially those related to handicapped. Refer to related schedules.

2 Car control panel is to be located in an approved vertical swing panel (in
convenient position), approved by the Engineer and is to contain at least the following:

(a) Up and down illuminated arrows.
(b) Alarm push button.
(c) Illuminated floor push buttons.
(d) Lights and fan controls.
(e) Key operated car cut-out service switch for isolation purposes.
(f) Priority/passenger key operated switch.
(g) Door open and door close pushes.
(h) Overweight light and buzzer.
(i) Emergency lighting test push-button.
(j) 2-way intercom hands free station (interconnected to the security room, lift machine room, and building reception).
(k) Maintenance and test switches with locked cover.

3 Car Position Indicator: A car position indicator(s) consisting of a red LED display shall be provided in the car. The position of the car shall be indicated by single or dual numeral and/or letter floor designations along with an arrow indicating direction of car travel. The position indicator shall be located above the Car Control Panel. A voice announcer, in English and Arabic, shall be provided to indicate operation of the doors and the floors where the elevator stops and the direction of the elevator.

4 Hall Push Buttons Stations: Comprise up and down pushes and associated illuminated arrows to indicate registered call. Terminal landings are to have one push and one arrow. Illuminated arrow is to switch off when call is answered. Push buttons are to be most up-to-date, mechanical, soft touch, metallic fitting in face panel.

5 Hall Position Indicator: Hall position indicator shall be provided to indicate the position of the car in the hoistway with single or dual numeral and/or letter floor designations along with an arrow corresponding to the direction of car travel. This shall be located in the elevator lobby at landing floors combined with the hall push button station. Audible sound and voice announcer shall indicate the travel direction.

6 At GF hall push button station shall be provided with illuminated push buttons. On top of each landing door a hall position indicator shall be provided. Characteristics are similar to above.

7 Push buttons characteristics are also to satisfy the recommendations of EN 81-70 – latest edition related to the requirements for disabled people. In addition, all devices operable by the general public shall be identified with Braille and/or tactile symbols. The car control panel(s) and hall pushbutton stations shall be located in accordance with code requirements to assist the handicapped.

8 Chime (for passengers' elevators) / Gong (for service elevators) is to be provided to indicate car arrival.
9 An electric alarm bell shall be provided in or adjacent to the elevator hoistway. This bell shall be connected to the alarm button in the car control panel.

10 Emergency key to open all landing doors is to be handed to the Employer.

11 Car control station is to project above car roof and is to contain necessary control pushes for maintenance, lamp with switch and convenience power socket.

12 Elevator bank control panel is to be provided for each elevator bank. Arrangement and design of panel are to be approved. Control and operating devices are to be properly identified by engraved signs. Panel is to include the following:

(a) Illuminated digital position and travel direction indicators for each elevator of the bank.

(b) Service switches, and internal regulating or adjusting devices etc. in accordance with system requirements.

(c) Control switches, alarm sounder and signal lights as needed.

13 Fireman switch, installed in a locked cabinet with break glass feature, is to be provided for each elevator bank and elevator dedicated for fire fighters’ use. Cabinets are to be located at main landing floor, in an approved easily accessible position. Identification and inscription are to be engraved on the faceplate. Refer to "Control Systems" Article for description of operation.

14 The characteristics of all above equipment and accessories shall be coordinated with the Engineer and subject to his approval.

15 Contractor to provide Elevator floor location and operation annunciators, as required by NFPA 101 and to be located in the Fire Command Center at GF level.

20.2.9 Control Systems

1 Interlock: No car is to be able to move unless car and corresponding landing doors are fully closed and interlocked. It is not to be possible to open landing door, except that at which car is stopped, and any other door without the use of special tamperproof key.

2 Emergency Operation: Equip elevators with control system to operate and recall cars in case of fire or any other specified emergency condition. Floor of recall to be determined based on fire conditions, obtained from the main Fire Alarm System. In case recall floor is on fire, elevators are to be directed to alternate floors.

3 Limit Switches shall be provided and set to function as close as possible to the terminal floors, without risk of accidental operation. They shall be located at top and bottom of well.

4 Operation from Stand-by / Emergency Supply: In the event of normal power supply failure all elevators are to stop. The “Emergency Power Automatic Landing System” will bring all the cars to the nearest landing; evacuate passengers, doors to close and elevator to remain stopped. Upon receiving
signal that Stand-by AC power supply is on, control system is to return dedicated elevators directly to main floor. These dedicated elevators are then to be operational, and are to respond to car and landing calls. After restoration of normal power supply all elevators are to resume normal service automatically.

5 Excess Load: Load-weighing device installed in car is to prevent car from starting in either direction if maximum loading (110% of rated load with a minimum of 75 kg) is exceeded. Buzzer is to sound and an 'overweight' light is to be illuminated until car is below maximum load. Excess load is to cause car to by-pass landing calls if car is loaded above normal but within an acceptable load limit.

6 Fireman Switch: Operation of switch is to separate elevator control, cancel all car and landing calls, prevent operation of door protective devices if provided and bring all cars to stop at main landing, with automatic doors open. Resetting of switch manually is not to be possible. Car is to resume operation manually from car push buttons.

7 The elevator operates in a stand-by mode during off-peak periods.

8 Control of Elevator Operation under Fire or Other Emergency Conditions (following details given as indication, Contractor to follow the related stipulations in the latest edition of ASME A17.1).

(a) Emergency return operation of cars to the main floor in case of emergency shall meet the following:

(ii) Each landing shall be provided with fire detection devices (smoke, heat or flame) at each floor except the main floor, and each elevator, or group of elevators in a common control shall be provided with a three position (on, off and by-pass) key operated switch at the main floor.

(iii) The key shall be removable only in the "on" and "off" positions.

(iv) When the key-operated switch is in the "on" position, all elevators, which are in automatic service, shall return non-stop to the main floor and the doors shall open and remain open.

1) Car(s) travelling away from the main floor shall revert to the next available floor without opening their doors.

2) For cars standing at a floor other than the main floor with doors open, the doors shall close immediately and the car shall proceed to the main floor.

3) Door reopening devices for power-operated doors, which are sensitive to smoke, heat or flame shall be rendered inoperative.

4) All car and landing floor call buttons, including access readers, shall be rendered inoperative and all call registered lights and direction lanterns shall be extinguished and remain inoperative.

(v) The activation of a fire detection device at any one of the landings shall cause the car(s) that serve that floor to return non-stop to the main floor and the doors shall open and remain open. Pre-designed levels shall be based on the overall evacuation plan.
1) The operation of the elevator shall require the manual resetting of the fire detectors.

2) In case of signal emanating from the specified main return floor then elevators are to be directed to an alternate floor to be specified.

(vi) When the switch is in the "by-pass" position the elevator shall revert to normal operation independent of fire detection devices.

(vii) When the switch is in the "off" position the elevator shall revert to normal operation.

(b) In-car operation of automatic elevators, in emergency operation: If it is required to provide for elevator to be operated under the control of emergency services personnel, such as firemen in an emergency, a two position (on and off) key-operated switch shall be provided for the purpose, inside the car, in addition to either of the switches mentioned in subparagraphs above.

(viii) The switch shall be effective only when the main floor switch is in the "on" position or the fire detection device (if provided) is activated and the car is at the main floor.

(ix) The key shall be removable only in the "off" position.

(x) When the switch is in the "on" position, it shall bring the elevator into the emergency mode of operation, as follows:

1) The elevator shall be operable only by a person in the car.
2) The elevator shall not respond to landing floor calls.
3) The opening of power-operated doors shall be controlled only by continuous pressure of the "open" button and if the button is released prior to the doors reaching the fully open position, the doors shall automatically re-close. Open doors shall be closed by either the registration of a car call button or by pressure on door "close" button.

(xi) Emergency operation from inside the car shall be cancelled when the switch is in the "off" position with the car at the main floor.

(c) Emergency return operation of ‘priority’ operated elevators:

Cars of such elevators shall be provided with a signal system consisting of both visual and audible types actuated at the main floor so as to alert the attendant to return non-stop to the main floor.

Provision shall be made to alert the attendant in the same manner when a fire detector (if any) is activated.

(d) When sprinklers are installed in the hoistway, control closet, or machinery spaces, a means to automatically disconnect the main line power supply of the affected elevator prior to the application of water is to be provided. Smoke detectors shall not be used to activate sprinklers in hoistways, control closets, or machinery spaces or to disconnect the main line power supply.

9 Selective Collective Control: Pressure upon one or more car buttons shall send
the car to the designated landings in the order in which the landings are reached by the car, irrespective of the sequence in which the buttons are pressed, provided the hoistway door interlock and car door switch circuits are completed. During this operation, the car shall also answer calls from the landings, which are in the prevailing direction of travel. Each landing call shall be cancelled when answered.

(a) Pressure upon a hall button at a floor above the car location shall cause the car to start up and answer any up calls, as they are reached by the car; irrespective of the sequence the buttons have been pressed. The car shall not stop at floors where down buttons only had been pressed. If no further car or up hall calls are registered, the car shall reverse its direction preference to response to car calls or down hall calls.

(b) The car shall start down to answer calls below the car and shall not stop where only up calls are registered. When travelling up, the car shall reverse at the highest call and proceed to answer calls below it. When travelling down, the car shall reverse at the lowest call and answer calls above it.

(c) Should both an up and a down call be registered at an intermediate landing, only the call responding to the direction in which the car is travelling shall be cancelled upon the stopping of the car at the landing. Terminal limit switches shall be provided in the hoistway designed to automatically stop the car at or near the closest terminal landing.

10 Group Operation:

(a) Individual Car Controller: shall be intelligent, solid state with high efficiency processors and have closed loop velocity and positioning. Individual car controllers will incorporate processors in a distributed scheme to provide maximum flexibility and computing power. A pre-selected controller (in addition to controlling its individual car), or an additional group controller (depending on the adopted configuration), shall be assigned as the system control manager. System redundancy in the group system shall be accomplished. Hall pushbutton risers shall be attached to the main group controller as well as the back up controllers. In the event that the main group controller can’t perform its duties, the system shall automatically switch to the next backup car controller. Communication between individual car controllers shall be accomplished through a serial link as well as concurrent communication through a secondary serial link.

(b) For each individual car controller, provide a serial card rack and main CPU board containing a non-erasable EPROM and operating system firmware. Variable field parameters and adjustments shall be contained in a non-volatile memory module. Serial ports shall be provided for connection to monitoring devices / diagnostic tools.

(c) Each elevator machine shall be provided with a tachometer or an encoder in order to provide accurate feedback to the controller as to car position.

(d) All individual elevator control adjustment parameters shall be stored in non-volatile memory within the computer control system.
(e) At each landing, a vane shall be installed to provide the code required floor zone detection. The vane shall also serve as a method for referencing absolute building points for the controller.

11 In the event of power loss, the elevator shall emergency brake to a stop. When normal power is restored, the elevator shall automatically restart. If power is restored under Emergency Power Conditions, the elevator shall operate as described in this specification under the separate heading, “Operation from Stand-by / Emergency Supply”.

20.2.10 Loose Equipment, Spare Parts And Accessories

1 Generally: Supply loose equipment, spare parts and accessories as required for normal operation and routine maintenance of the systems and as detailed by the Contractor in his offer for spare parts and accessories. Supply is to include, but is not limited to, the following:

(a) Loose Equipment: Operating handles, emergency brake release keys and the like.

(b) Spare Parts: One complete set of main contacts and control coil for each type of power contactor, solid-state PC cards, contacts and control coils for each type of control relay, two each of transistors, diodes, rectifiers, resistors etc. used in control circuits, one complete set of indicating lamps, fuses, capacitors, circuit-breakers, contact points etc., air filters, brushes, bearings and the like, as necessary for two years operation.

(c) Tools and Accessories: Tools and equipment required for routine checking, maintenance, testing and control of installations, with appropriate portable measuring and test instruments.

2 Identification: Parts are to be packed in sealed plastic bags with identifying labels and factory part list numbers.

20.3 EXECUTION

20.3.1 Examination

1 Examine elevator areas, with the Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of elevator work. Examine hoistways, hoistway openings, pits, and machine rooms, as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed. Do not proceed with installation until unsatisfactory conditions have been corrected.

20.3.2 Installation

1 General:

(a) Install equipment in accordance with approved shop drawings, referenced codes and specifications.

(b) Install equipment with clearances complying with referenced standards and Specification.
(c) Install equipment to afford maximum safety and continuity of operation in event of seismic activity.

(d) Adjust motors, brakes, controllers, limit switches, stopping switches, levelling switches, door operators, interlocks and safety devices in order to achieve required performance levels.

(e) Comply with manufacturer's instructions and recommendations.

2 Coordination: Coordinate elevator work with work of other trades for proper time and sequence to avoid construction delays. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work. Coordinate equipment installations with the building construction to prevent alteration to structure and cutting of holes and chases after equipment installation has started. Ensure provision of pit screen separators between adjacent elevators and for screening of counterweight to a height of 2.5 m from bottom of pit for safety of maintenance personnel.

3 Assembly: Equipment is, as far as possible, to be factory assembled, wired and tested. Site work is to be limited to installation and assembly of parts dismantled at factory for transportation, or otherwise to work not possible at factory.

4 Workmanship: Carry out work in a neat, workmanlike and efficient manner in accordance with specified requirements. Installation is to be performed by skilled personnel, specialized in elevator installation, who are in the permanent employment of the manufacturer or manufacturer’s authorized dealer.

5 Accessibility:
   (a) Install equipment so that it is readily accessible for operation, maintenance and repair.
   (b) Equipment layout should allow easy removal by portable hoists or other means for maintenance or repair.

6 Builder's Work: Carry out all builders' work necessarily required in connection with installation of elevators, including but not limited to, forming or cutting chases, rebates, etc., grouting, supports, steelwork, scaffolding, etc. Provide convenience power, lighting and other services required, from assigned terminal points, to carry out construction work.

7 Fixing Elevator Guide Rails: Keep rails in proper alignment using steel splice plates of adequate strength. Verticality of rail is to be within 0.2% tolerance. Space fixing brackets to minimize rail vibration during operation, and at not more than 2 m centres.

8 Painting: Protect unfinished metalwork by painting, unless technically undesirable. Painting is to include thorough cleaning of metal, application of rust inhibiting prime coat and two finishing coats of approved enamel.

9 Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby, eliminate sources of structure-borne noise from elevator system. Refer to Acoustics report requirements.

10 Lubricate operating parts of systems, including ropes, as recommended by
manufacturers.

11 Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

12 Levelling Tolerance: 3-mm up or down, regardless of load and direction of travel.

20.3.3 Field Quality Control

1 GENERAL

(a) Provide all labour, materials and instruments required for the tests.

(b) Advise the Employer, Engineer and Authorities having jurisdiction in advance of dates and times tests are to be performed on.

2 TESTS

(a) Factory Tests: Upon completion of equipment manufacture and before shipping, perform all required tests by the standards (refer to Section 16 of EN 81-1). Results of all tests performed shall be conveyed to the Employer / Engineer at least 21 days before shipping. Tests are to demonstrate the conformity of equipment to the Specification and to governing standards. Copies of these tests are to be duly submitted along with a Type Test certificate. All applicable type test reports for standard equipment used in the system shall be submitted at the Tender stage.

(b) Field Quality Tests:

(i) After installation is complete and before hand-over, carry out acceptance tests as required and recommended by the standards (refer to Section 16 and Annex D of EN 81-1) and governing regulations and authorities. Carry out any other tests the Engineer may require to check safety and compliance of installation with the Specification. Tests are to be witnessed by the Engineer, the approved testing agency and, if required, by the concerned Authority. Following tests are given for indicative purposes only:

1) Insulation resistance test.
2) Speed, levelling and running of elevator with no load and full load in car including starting, accelerating, decelerating, door operation, etc.
3) Free fall tests.
4) All safety measures tested to the requirements of the Code.
5) Run fully loaded car continuously for a period of one hour.
6) Handling capacity test by carrying out real simulations.

During these tests the motor winding temperature shall be monitored. Specified speed and time shall be met.

(ii) Equipment Failure: make good any damage to equipment caused by tests or damage to building caused by failure of any part of the installation, to the satisfaction of the Engineer.
3 Final Acceptance Test: Final acceptance of installation shall be carried out, as required and recommended by the "Code" and governing regulations (local and international) and agencies, only after all field quality tests are complete and all submittals and required certificates approved by the Engineer. Above Field quality tests are to be repeated, in front of same attendees. Compliance of workmanship and equipment with specification is to be checked.

20.3.4 Cleaning

1 During work progress, always keep work areas clean and free from debris.

2 Keep machine room, hoistway, car, fixtures, etc. always clean

20.3.5 Demonstration

1 Engage a factory-authorized service representative to train Employer’s maintenance personnel on procedures and schedules for maintaining, operating, adjusting, troubleshooting, and servicing elevators.

(a) Make a final check of each elevator operation, with Employer’s maintenance personnel present, just prior to Substantial Completion. Determine that operation systems and devices are functioning properly.

20.3.6 Protection

1 Temporary Use: Do not use elevators for construction purposes unless otherwise approved in writing by the Engineer and cars are provided with temporary enclosures, either within finished cars or in place of finished cars, to protect finishes from damage.

(a) Provide full maintenance service by skilled, competent employees of the elevator Installer for elevators used for construction purposes. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Use parts and supplies as used in the manufacture and installation of original equipment.

(b) Provide protective coverings, barriers, devices, signs, or other procedures to protect elevators. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

2 Provide final protection and maintain conditions, in a manner acceptable to elevator manufacturer and Installer, that ensure elevators are without damage or deterioration at the time of Substantial Completion.

20.3.7 Elevators' Schedules

1 Elevator 1 & 2 (2 Nos.):

(a) Type of Service: Passenger.

(b) Number of Passengers: 21.

(c) Load: 1600 kg.
(d) Speed: 1.0 m/sec.
(e) Number of Starts per Hour: 240.
(f) Position of Machine Room: Machine Roomless
(g) Power Drive: VVVF.
(h) Control System: Selective Collective Control.
(i) Total Travel: 10.95m
(j) Floors Served: Basement, Ground Floor, First Floor
(k) Entrance Door Type:
   i. Car: Central Automatic Sliding.
   ii. Landing: Central Automatic Sliding.
(l) Main Parking Floor: Ground.
(m) Car Type: Single Entrance
(n) Car Platform Size: 2100 mm wide x 1600 mm deep.
(o) Door Opening: 0.9 m.
(p) Hoistway Dimensions:
   i. Width: 5.55 m.
   ii. Depth: 2.5 m.
   iii. Construction: Concrete.
(q) Pit Depth: 1.6 m.
(s) Buffer Type:
   i. Car: Spring.
   ii. Counterweight: Spring.
(t) Guide Shoes:
   i. Car: Roller.
   ii. Counterweight: Roller
(u) Safety Gear: Gradual.
(v) Compensation Ropes: Not Needed
(w) Intercom/Telephone Station: Needed.
(x) Finishes:
   i. Car:
      1) Walls: Satin Stainless Steel panel
      2) Doors: Brushed Stainless steel
      3) Sills: Brushed Stainless steel
      4) Ceiling: Brushed Stainless steel
      5) Flooring: Resilient sheet floor
      6) Skirting, Kick-Plates and Guard Rails: Brushed Stainless steel
7) Lighting: Efficient lighting such as LED
8) Fan: Concealed.
9) Mirror: Yes

ii. Control and Position Indicator Plates: Brushed Stainless steel bevelled edge

iii. Architrave and General Trim: Brushed Stainless steel

iv. Landing Doors: Brushed Stainless steel

v. Landing Sills: Brushed Stainless steel

iv. Colour: Golden and as approved by Engineer

2 Elevator 3 (1 Nos.):

(a) Type of Service: Passenger.

(b) Number of Passengers: 21.

(c) Load: 1600 kg.

(d) Speed: 1.0 m/sec.

(e) Number of Starts per Hour: 240.

(f) Position of Machine Room: Machine Roomless

(g) Power Drive: VVVF.

(h) Control System: Directional Collector Control

(i) Total Travel: 10.95m

(j) Floors Served: Basement, Ground Floor, First Floor

(k) Entrance Door Type:

i. Car: Central Automatic Sliding.

ii. Landing: Central Automatic Sliding.

(l) Main Parking Floor: Ground.

(m) Car Type: Thorough Type

(n) Car Platform Size: 2100 mm wide x 1600 mm deep.

(o) Door Opening: 0.9 m.

(p) Hoistway Dimensions:

i. Width: 2.75 m.

Depth: 2.50 m.

i. Construction: Concrete.

(q) Pit Depth: 1.6 m.


(s) Buffer Type:

i. Car: Spring.

ii. Counterweight: Spring.

(t) Guide Shoes:
i. Car: Roller.

ii. Counterweight: Roller

(u) Safety Gear: Gradual.
(v) Compensation Ropes: Not Needed
(w) Intercom/Telephone Station: Needed.
(x) Finishes:

i. Car:
   1) Walls: Satin Stainless Steel panel
   2) Doors: Brushed Stainless steel
   3) Sills: Brushed Stainless steel
   4) Ceiling: Brushed Stainless steel
   5) Flooring: Resilient sheet floor
   6) Skirting, Kick-Plates and Guard Rails: Brushed Stainless steel
   7) Lighting: Efficient lighting such as LED
   8) Fan: Concealed.
   9) Mirror: Yes

ii. Control and Position Indicator Plates: Brushed Stainless steel bevelled edge

iii. Architrave and General Trim: Brushed Stainless steel

iv. Landing Doors: Brushed Stainless steel

ii. Landing Sills: Brushed Stainless steel

iii. Colour: Golden and as approved by Engineer

3 Elevator 4 (1 Nos.):

(a) Type of Service: Hospital.
(b) Number of Passengers: 33.
(c) Load: 2500 kg.
(d) Speed: 1.0 m/sec.
(e) Number of Starts per Hour: 240.
(f) Machine Roomless
(g) Power Drive: VVVF.
(h) Control System: Directional Collector Control.
(i) Total Travel: 10.95m
(j) Floors Served: Basement, Ground Floor, First Floor
(k) Entrance Door Type:
   i. Car: Central Automatic Sliding.
   ii. Landing: Central Automatic Sliding.
(l) Main Parking Floor: Ground.
(m) Car Platform Size: 1800 mm wide x 2700 mm deep.

(n) Door Opening: 1.3 m.

(o) Hoistway Dimensions:
   i. Width: 3.50 m.
   ii. Depth: 3.30 m.
   iii. Construction: Concrete.

(p) Pit Depth: 1.9 m.

(q) Electric Power Supply: AC 240/415 V, 50 Hz.

(r) Buffer Type:
   i. Car: Spring.
   ii. Counterweight: Spring.

(s) Guide Shoes:
   i. Car: Roller.
   ii. Counterweight: Roller

(t) Safety Gear: Gradual.

(u) Compensation Ropes: Not Needed

(v) Intercom/Telephone Station: Needed.

(w) Finishes:
   i. Car:
      1) Walls: Satin Stainless Steel panel
      2) Doors: Brushed Stainless steel
      3) Sills: Brushed Stainless steel
      4) Ceiling: Brushed Stainless steel
      5) Flooring: Resilient sheet floor
      6) Skirting, Kick-Plates and Guard Rails: Brushed Stainless steel
      7) Lighting: Efficient lighting such as LED
      8) Fan: Concealed.
      9) Mirror: Yes
   ii. Control and Position Indicator Plates: Brushed Stainless steel bevelled edge
   iii. Architrave and General Trim: Brushed Stainless steel
   iv. Landing Doors: Brushed Stainless steel
   i. Landing Sills: Brushed Stainless steel
   ii. Colour: Golden and as approved by Engineer
21 LIGHTNING PROTECTION

21.1 SYSTEM OBJECTIVES

21.1.1 Performance Objectives

1 To provide protection to buildings and their contents including human life, from exposure to the effects of unsafe electrical currents and potentials, which occur during thunderstorms and when there are lightning strikes.

2 To ensure the safe discharge to earth of electrical currents generated by lightning strikes and other atmospheric disturbances.

3 To limit rise of potential relative to the earth on exposed conductive materials, due to the passage of currents generated by lightning strikes and other atmospheric disturbance.

4 To retain system voltages within reasonable limits under lightning conditions and other power system disturbances to ensure that insulation breakdown voltages are not exceeded.

21.1.2 Design Parameters

1 To provide protection to buildings lightning protection is done in accordance with BS EN 62305 (Part I – IV) in conjunction with BS EN 50164 (material standards incorporated in BS EN 62305) and BS-7430 where applicable.

2 Surge Protection of electronic equipment shall be provided in accordance with BS EN 62305 – Part IV.

3 The cage around the building is comprised of steel structure, down conductors and earth electrodes. The aim is to provide a means of safely discharging to earth electrical currents from lightning discharges, which requires the overall resistance to earth of each earth electrode of the Lightning Conductor System being less than 10 Ohms.

4 Contractor shall submit the risk evaluation calculation based on BS EN 62305 – II and then shall employ the air termination network consisting of mesh of either 20m x 20m or less, in co-ordination with the rolling sphere (size as per the protection level) and the service entrant surge protectors (as per the protection level), depending on the Lightning Protection Level (LPL) to be used to bring down the risk (R) below the tolerable risk level (RT). The number, size and spacing of the conductors forming the air termination network and the down conductors shall be arranged in accordance with the recommendations of BSEN-62305.

5 Down conductors shall be connected to the earth mesh via test links in accordance with BSEN 62305 (Part I – IV). Test links are to be accessible and located in appropriate enclosures.

6 Down conductors shall run at the outer surface of the building.

7 Down conductors shall be high conductivity, copper tape 25 x 3 mm covered with PVC. PVC color to be approved by architect.
8 Copper cable used as ring conductor tape should be bonded to all down conductors around the periphery.

9 All the fixing clips for the copper tape shall be metallic (complying with Class ‘H’ of the electrical testing based on BSEN 50164) and shall be fixed at an interval of 500mm (1000 mm fixing distance for fixing conductors on vertical surface up to 20m from the ground level).

10 Precautions shall be taken to ensure that bi-metallic corrosion will not occur, between joints in the system, which comprise of dissimilar metals.

11 The system shall incorporate the required test facilities to allow testing of the system in accordance with BS EN 62305 and BS-7430.

12 Precautions shall be taken to ensure all exposed conductive metalwork, which could become electrically charged during a thunderstorm, is bonded to the lightning protection system.

21.1.3 System Description

1 The system shall comprise of various elements and components as described hereafter in the enclosed specification.

2 The specifications and project drawings are indicative and are provided to explain the intent of the provision. It is the Contractor’s responsibility to consult the standards and provide a complete network as required.

21.1.4 System Drawings and Schematics

1 Design, supply and install a lightning protection system in accordance with the enclosed specified standards.

2 Provide detailed plans and schematic diagrams.

3 Engage an earthing and lightning protection systems specialist to carry out the Design, Installation, Testing and Commissioning of the lightning protection system. This shall be done in coordination with the requirements for Part 22 “Earthing and Bonding” and QGEWC specifications for “Surge Protection Devices”.

21.2 PARTICULAR REQUIREMENTS

21.2.1 Standards

1 Provide lightning protection system in accordance with BSEN 62305 (Part I – IV)

2 Provide lightning protection connection components complying with BS- EN 50164-1 and BS- EN 50164-2.

3 Provide earthing elements in accordance with BS-7430 and Part 22 requirements.

21.2.2 Use Of Building Elements

1 Ensure that building and structural elements used as items in or bonded to the
lightning protection system are designed and erected in accordance with related BS as well as their appropriate constructional specification or code of practice. Ensure that all connections to building and structural elements are waterproof and corrosion protected to a degree appropriate to their exposure.

21.2.3 Regulations And Agreements and Approvals

1 Obtain the approval of all authorities concerned for the installation of the lightning protection system. Comply with the regulations of all concerned authorities for the installation and connection of public utility services to an integrated earth termination network, comply with agreements made with bodies concerned with other services connected to a common earth termination network.

21.2.4 Bonding Of Services

1 Bond or isolate all metallic services in or on the structures in accordance with BSEN 62305 (PART I – IV).

21.2.5 Protection Of Electronic Equipment

1 Surge Protection of electronic equipment shall be provided in accordance with BS EN 62305 – Part IV.

2 Refer to QGEWC specifications “Surge protection devices” for details of the protection to electronic equipment in buildings in accordance with BS EN 62305 – Part IV.

3 Protect telecommunication lines in accordance with BS EN 61663.

21.2.6 Lightning Protection Detail Drawings

1 Ensure the installation is carried out according to the enclosed standard details and/or details approved by the Engineer.

21.3 PRODUCTS/MATERIALS

21.3.1 Test Joints

1 Test joints shall be to the Engineer approval and of a type complying with BS EN 62305 & BS EN 50164 with the following minimum requirements:
   (a) Conductor Form: Rod/Strip/Stranded/Flexible.
   (b) Material: Copper
   (c) Link disconnecting Base: Copper Alloy Conforming to BSEN 50164
   (d) Test and Junction Clamp: Square/Oblong/Plate/Screw-down/Bi-metallic conforming to BS EN 50164
   (e) Corrosion inhibitor shall be used on disconnecting joints
   (f) Lugs and tags

21.3.2 Conductors

1 Provide conductors for lightning protection system in accordance with BS EN 62305, including, but not limited to:
21.3.3 Building Elements

1. Where applicable, use building elements as down conductors and main terminations in accordance with BS EN 62305, with non-ferrous bonding points.

21.3.4 Lightning Protection System Bonds (Compliance To BSEN 50164)

1. Lightning protection system bonds shall be to the Engineer approval and of a type complying with BSEN 62305, with the following minimum characteristics:
   (a) Material: Copper or other approved metal Rigid/Flexible/Re-bar
   (b) Bond material Form: Stranded/Flexible
   (c) Material Copper to BS 6360.

21.3.5 Decorative Finials

1. Decorative finials shall be to the Engineer approval and of a type complying with BS EN 62305.

21.4 WORKMANSHIP

21.4.1 Installation

1. Install the lightning protection system and its element in accordance with the manufacturer's recommendations and BS EN 62305 and BS 7430.

21.4.2 Work on Site

1. Ensure that all building works are completed and service connections are provided.

21.4.3 Quality Control

1. Handle, store and install all equipment and components of the lightning protection system in accordance with the manufacturer's recommendations and BS EN 62305, BS 7430.

2. Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any, which are defective.

3. Test and commission the system in accordance with BS EN 62305 and as specified.

4. Record all test measurements.
21.4.4 Bonding

1. Bond or isolate building structural elements and metallic services as BS EN 62305, including, but not limited to the following:
   
   (a) Steel structural frame
   (b) Reinforcement bars in concrete
   (c) Metallic roof coverings
   (d) Television and radio aerials and supports
   (e) Metal flues and flue lining
   (f) Window cleaning gear
   (g) Water services
   (h) Air duct lines
   (i) Gas services
   (j) Flag-masts
   (k) Roof level equipment and plant rooms
   (l) Main equipotential bonds
   (m) Supplementary equipotential bonds

21.4.5 Labelling

1. Provide and fix system labels as required by BS EN 62305.

21.4.6 Installation Records

1. Prepare system records in accordance with the conditions of contract and BS EN 62305:
   
   (a) As installed drawings
   (b) Earth electrode resistance
   (c) Details of earth electrodes: Type/Location
   (d) Reference electrode
   (e) Alterations to system

21.5 MAINTENANCE

1. Carry out maintenance as required by BS EN 62305 for the defects liability period and provide proposal for continuing maintenance to the Engineer/Building owner.

21.6 TESTING AND COMMISSIONING:

1. Test and commission the system in accordance with BS EN 62305 and BS 7430 and as specified. Record all test measurements.

2. Continuity tests and earthing tests shall be undertaken to the satisfaction of the Engineer when the installation has been completed.
21.7 QUALITY CONTROL

1. Handle, store and install all equipment and components of the lightning protection system in accordance with the manufacturer's recommendations and BS 7430, BS 7671, BS EN 62305 & BS EN 50164.

2. Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any, which are defective.
22. EARTHING AND BONDING

22.1 GENERAL

22.1.1 Description of Work

1 Complete installations to earth every source of energy and to provide protective earthing and equipotential bonding, based on the TN-S system arrangement, including:

(a) Transformer neutral earthing
(b) MV main earthing terminals or bars
(c) Exposed conductive parts of electrical equipment
(d) Extraneous conductive parts
(e) Standby generators neutral earthing
(f) Low current and communication systems

22.1.2 Regulations and Standards

1 Carry out work in accordance with the latest edition of the following:

(a) IEC 50364-53 and 60364-4-41: Electrical Installations in Buildings
(b) BS 7671 - IEE Regulations for Electrical Installations in Buildings

22.1.3 Definitions of Terms

1 Used on the drawings and in the specification are as follows:

(a) EARTH: conductive mass of the Earth whose electric potential at any point is conventionally taken as zero
(b) EARTH ELECTRODE: conductor or group of conductors in initial contact with, and providing electrical connection to, Earth
(c) EXPOSED CONDUCTIVE PART: any part which can be readily touched and which is not a live part, but which may become live under fault conditions
(d) EXTRANEOUS CONDUCTIVE PART: any conductive part not forming part of the electrical installation such as structural metalwork of a building, metallic gas pipes, water pipes, heating tubes etc. and non-electrical apparatus electrically connected to them i.e. radiators, cooking ranges, metal sinks etc. and non-insulating floors and walls
(e) PROTECTIVE CONDUCTOR: conductor used for some measure of protection against electric shock and intended for connecting together any of the following parts:
   (i) Exposed conductive parts
   (ii) Extraneous conductive parts
   (iii) Earth electrode(s)
(iv) Main earthing terminal or bar(s)
(v) Earthed point of the source(s)

(f) Electrically Independent Earth Electrodes: earth electrodes located at such distance from one another that maximum current likely to flow through one of them does not significantly affect the potential of the other(s)

(g) Main Earthing Terminal Or Bar: the terminal or bar provided for the connection of protective conductors, including equipotential bonding and functional earthing conductors if any to the means of earthing

(h) Equipotential Bonding: electrical connection to put exposed and extraneous conductive parts at a substantially equal potential

(i) Earthing Conductor: protective conductor connecting main earthing terminal or bar of an installation to earth electrode or to other means of earthing

22.1.4 Equipment Data

1 Prior to ordering materials, submit data for approval including, but not limited to, manufacturer's catalogues for earth rods, connecting clamps, earthing conductors, protective conductors, bonding conductors, connectors and other accessories, exothermic welding kits and tools etc., and samples of conductors as requested

22.1.5 Shop and Construction Drawings

1 Submit drawings for approval including, but not limited to, the following:

(a) Exact routing of buried earthing conductors with indication of cross-section, depth of laying and covering
(b) Cross sectional area of all earthing, protective and bonding conductors
(c) Layout and details of earthing provisions at substations, generator rooms, switchgear, distribution panelboards, IT centre and related UPS, special rooms, etc., indicating fittings used, insulation, plates and marking, passage and routing of earthing conductors, conduit, sleeves, grooves, niches etc., giving sizes and dimensions of component parts.

22.2 PRODUCTS AND SYSTEMS

22.2.1 Earthing System (Type TN-S)

1 Component parts of earthing system are to include the following:

(a) Earth electrode
(b) Main earthing terminals or bars
(c) Earthing conductors
(d) Protective conductors
(e) Equipotential bonding conductors
(f) Electrically independent earth electrodes for special systems
(g) Accessories and termination fittings, bonding, welding kits and other materials.
22.2.2 Main Earthing Bar

1 Main Earthing Bar is to be provided at point of service entrance or main distribution room, and as described in the Specification or shown on the Drawings, to which all earthing conductors, protective conductors and bonding conductors are to be connected. Two insulated main earthing conductors are to be provided, one at each end of the bar, connected via testing joints to the earth electrode. Conductor is to be sized to carry maximum earth fault current of system at point of application with final conductor temperature not exceeding 160 deg. C for at least 5 seconds. Main earthing conductors are to be minimum 120 mm² or as otherwise required by the particular Section of the Specification, and/or as shown on drawings.

22.2.3 Testing Joints (Test Links)

1 Testing joints are to be provided, in an accessible position, on each main earthing conductor, between earthing terminals or bar and earth electrode.

22.2.4 Protective Conductors

1 Protective conductors are to be separate for each circuit. Where protective conductor is common to several circuits, cross-sectional area of protective conductor is to be the largest of the conductor sizes. Selection of sizes is to be in accordance with Table 54G of BS 7671.

2 Protective conductors are not to be formed by conduit, trunking, ducting or the like. Where armoured cable is specified and armour is steel, it may be used as a protective conductor, if approved and if not otherwise shown on the Drawings.

3 Series connection of protective conductors from one piece of equipment to another is not permitted. Extraneous and exposed conductive parts of equipment are not to be used as protective conductors, but are to be connected by bolted clamp type connectors and/or brazing to continuous protective conductors which are to be insulated by moulded materials.

22.2.5 Earth Fault Loop Impedance

1 For final circuits supplying socket outlets, earth fault impedance at every socket outlet is to be such that disconnection of protective device on overcurrent occurs within 0.4 seconds, and for final circuits supplying only fixed equipment, earth fault loop impedance at every point of utilization is to be such that disconnection occurs within 5 seconds. Use appropriate tables and present same for approval by the Engineer (BS 7671: Table 41A Appendix 9 Regulation 543).

22.2.6 Supplementary Equipotential Bonding

1 All extraneous conductive parts of the building such as metallic water pipes, drain pipes, other service pipes and ducting, metallic conduit and raceways, cable trays and cable amour are to be connected to nearest earthing terminals by equipotential bonding conductors. Cross-section of protective bonding conductor is not to be less than half that of the protective conductor connected to respective earthing terminal and minimum 4 mm².
22.2.7 Main Equipotential Bonding

1. Main incoming and outgoing water pipes and any other metallic service pipes are to be connected by main equipotential bonding conductors to main earth terminal or bar. Bonding connections are to be as short as practicable between point of entry/exit of services and main earthing bar. Where meters are installed, bonding is to be made on the premises side of the meter. Cross-sections of conductors are not to be less than half that of the earthing conductor connected thereto, and minimum 6 mm².

22.2.8 Identification

1. Connection of every earthing conductor to earthing electrode and every bonding conductor to extraneous conducting parts is to be labelled in accordance with the Regulations, as follows:

   "SAFETY ELECTRICAL CONNECTION – DO NOT REMOVE"

2. Protective and earthing conductors are to be identified by combination of green-and-yellow colours of insulation or by painting bar conductors with these colours, as approved.

3. Source earthing conductor (or neutral earthing conductor) is to be identified along its entire length by continuous black insulation labelled ‘neutral earthing’.

22.2.9 Materials and Products

1. Earthing Conductors: insulated or bare copper conductor as described in the Specification for the particular application.

2. Testing Joints (Test Links): copper or copper alloy, with bolted end connections, disconnectable by use of a tool, and suitably sized for earthing conductors or earth bar connection. Links are to be fixed to porcelain or other approved insulating supports. Contact surfaces are to be tinned.

3. Protective Conductors: single core stranded annealed copper, PVC insulated cables, having rated insulation grade compatible with circuit protected, or to be a conductor forming part of a multi-core cable, colour coded.

4. Main Earthing Bar: hard drawn copper, 40 x 4 mm where formed into a closed loop, and 50 x 6 mm where open ended. Earth bar is to be labelled 'Main Earth Bar' and is to be drilled, for connection of conductors, at a spacing not less than 75 mm, and is to be supplied with copper alloy bolts, nuts and washers and wall mounting insulators.

5. Protective Bonding Conductors: bare copper strip conductor, annealed stranded copper cable or flexible strap (flexible braid).

6. Earthing Accessories: copper or copper alloy, purpose made, of approved design, compatible with points of connection, and of adequate cross-section and current carrying capacity. Connectors and clamps are to be bolted type. Bolts, nuts and washers are to be high quality phosphor bronze or copper silicon alloys.
7 Earth Electrode
   (a) shall be of the earth rod type
   (b) earth rod electrodes: 16 mm diameter steel core copper jacketed type, comprising a high strength steel alloy core with a molten welded copper covering
   (c) to be 3.6 m long, in 1.2 m sections coupled by strong bronze couplers or the earth electrode shall be installed at such a depth that it penetrates the summer water table by a minimum of 2 metres.

8 Earth Pit: provide a concrete/PVC pit complete with a heavy duty concrete, cast iron or PVC cover with recessed lifting hook to the Engineers written approval, at the head of the earth rod, to protect the rod and allow access to connections for testing. Earth Pit Cover shall be of heavy duty construction and shall have a brass plate, engraved “Electrical Earth Below”.

22.3 FIELD AND INSTALLATION WORK

22.3.1 Installation

1 Continuity: ensure that complete earthing system is electrically continuous and mechanically secure.

2 Earthing Conductors are to follow shortest path between earth rods and main earthing terminals or bars, and are to run in PVC conduit (duct) fastened to building structure by approved supports and are to be protected against mechanical damage and corrosion.

3 Protective Conductors: separate protective conductors, which are not part of a cable, are to be fixed on same support or drawn into same conduit as circuit conductors.

4 Protective Bonding: remove any non-conductive paint, enamel or similar coating at threads, contact points and surfaces and ensure that bonding is made by fittings designed to make secure bonds.

5 Protection against Corrosion: protect bolted connections against corrosion either by filling with Vaseline or coating with a special anti-corrosion compound and proper capping.

6 Connections: earth connections are to be readily accessible. If inaccessible earth connection is permitted, approved exothermic welding or brazing technique is to be employed.

7 Connections: where earth connections between dissimilar metals must be made, use bimetallic fittings and protect by coating with moisture resisting bituminous paint or compound, or by wrapping with protective tape to exclude moisture.

22.3.2 Tests on Site and Records

1 Electrical Continuity of all earthing and protective conductors including main and supplementary equipotential bonding conductors is to be checked.

2 Earth Fault Loop Impedance of all circuits is to be measured and checked against
calculated impedance figures.

3 Operation of residual current protective devices is to be checked.

4 Records: submit the following:
   (a) Scaled drawings, as-installed, showing actual layout and specification of all components of earthing system
   (b) Nature of soil and any special earth arrangements, etc.
   (c) Date and particulars of soil conditioning method and agents if used
   (d) Test conditions and results obtained.
23. DUMBWAITERS

23.1 GENERAL

23.1.1 Scope

1 This part specifies the general requirements for Electric traction dumb waiters and accessories. It shall be read in conjunction with other parts of the specifications and the project drawings.

2 Related Parts and sections are as follows:

Part 1 General Provisions for Electrical Installations

23.1.2 Reference Standards

1 Regulatory Requirements: In addition to local governing regulations, comply with the following, referred to as the "Code":


b. ASME A17.1, "Safety Code for Elevators and Escalators".

23.1.3 DEFINITIONS

1 Dumbwaiters: Hoisting and lowering mechanisms equipped with cars of limited size and including driving machines; cars; hoistway doors; access doors; guide rails; roping; buffers; counterweights (if any); signals; control systems; electrical wiring within dumbwaiter systems; and devices for operations, safety, security, and required performance; and for complete dumbwaiter installation.

23.1.4 QUALITY ASSURANCE

1 Engage the dumbwaiter manufacturer or an experienced Installer approved by the dumbwaiter manufacturer who has completed dumbwaiter installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

2 Provide insulated hollow-metal door-and-frame units identical to door and frame assemblies tested for fire-test-response characteristics and rated 1-1/2 hour.

23.1.5 Submittals

1 Usually review catalog information before editing this Section and delete below.

2 Product Data: Include capacities, sizes, performances, operations, safety
features, controls, finishes, and similar information.

3 Shop Drawings: Show general arrangement plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure and relationships with other construction. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, locations of controls, and access and ventilation for machinery rooms and hoistways.

4 Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate clearly between manufacturer-installed and field-installed wiring. Indicate maximum and average power demands.

5 Delete below if only normal materials and signal units are specified.

6 Samples: For exposed finishes for car, hoistway doors, and signal equipment; 75 mm square samples of sheet materials; and 100 mm lengths of running trim members.

7 Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by Engineer.

8 Maintenance Manuals: For each different dumbwaiter, including operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include all diagnostic and repair information available to manufacturer's and Installer's maintenance personnel. Submit for Employer's information at project closeout.

23.1.6 Warranty

1 Manufacturer's Warranty: Provide a written warranty signed by the dumbwaiter manufacturer agreeing to repair, restore, or replace defective item within the specified warranty period. Spare parts required under related Article hereunder are not part of this requirement.

(a) Warranty Period: 12 months from date of Substantial Completion.

23.2 PRODUCTS

23.2.1 Machine and Drive

1 Geared Machine-Drive: Worm-geared type with motor, brake and traction sheave in proper alignment on steel bedplate or base.

2 Worm and Shaft: An integral unit, cut from solid steel forging or steel bar stock.

3 Worm Gear: Accurately machined bronze, bolted to spider. Enclose worm and gear in cast iron gear case.
4 Traction Sheave: High quality cast iron or steel, of proper diameter for hoisting ropes, and grooved to provide proper traction with minimum rope wear.

5 Bearings: Ball or roller type.

6 Brake: Electro-magnetic type, spring applied and electrically released, designed to stop and hold car under all conditions and capacity load.

7 Accessibility: Ensure all parts are easily accessible for lubrication and maintenance.

8 Electric Motor: Single speed type, arranged to bring car into landing at reduced speed to within 6 mm of landing sill level. Motor is to have sufficient capacity to operate continuously with contract load and contract speed without overheating.

9 Locate machine directly over hoistway. Provide all necessary structural beams or channels and bearing plates and fasten securely to building structure. Provide any additional structural members necessarily required for equipment installation.

10 Sound Reduction: Isolate machine from beams with rubber pads.

23.2.2 Car

1 Construction: Stainless steel grade 304 or 316, with sides and rear walls not less than 15 mm thick and bottom not less than 2 mm thick, and constructed to carry loads without distortion.

2 Shelves: Provide two, 2 mm thick removable shelves with 12 mm high lip on all sides, in car.

3 Lighting: Provide recessed light in top of car.

23.2.3 Station Entrances

1 Head and Jambs of Door Frame: Stainless steel plate, not less than 2 mm thick, with corners welded, ground smooth and neatly finished.

2 Doorframe at bottom landing is to be of sufficient width to permit removal of car from hoistway. Removable filler pieces of approved design are to be neatly fitted into bottom landing unit to reduce frame opening to typical width.

3 Hoistway Doors: Counter-balanced, vertical bi-parting type, 25 mm thick, comprising two 2 mm thick flat metal sheets, reinforced at all edges and filled with cellular asbestos. Finish hall side of doors and exposed edges in stainless steel. Paint finish shaft side with rust inhibiting paint. Provide a vision panel in top section of each door. Door sections are to ride freely in steel guides and are to be suspended on steel cable, operating over ball bearing sheaves.

4 Interlocks And Door Lock: Provide combination interlock, electric contact and door lock on each door, arranged to prevent opening of doors from hall side
unless car is at that landing, and which will prevent movement of car unless doors are locked in closed position.

23.2.4 Auxiliaries

1 Guide Rails: Cold rolled steel or steel standard channel or tee sections, of sufficient size to prevent distortion or misalignment, secured by approved clamps or brackets, aligned to within 3 mm of plumb, and extending from floor of bottom landing to top hoistway.

2 Guide shoes are to have removable metallic or non-metallic gibbs. If metallic gibbs are supplied, automatic lubrication in machine room is to be arranged to distribute lubricant evenly to rails.

3 Lubrication system is to contain provisions for regulating flow of lubricant. Approved metal pans are to be provided at bottom of rails to collect lubricant.

4 Counterweight: Sectional type, equal to weight of complete car and approximately 40% of contract load. Hold sections in place by tie rods to prevent shifting.

5 Limit Switches: Arrange normal and final limit switches to stop car automatically at terminal landings independent of regular operating devices.

6 Control plates are to contain devices required for specified operation. Faceplates are to be stainless steel of approved design.

7 Painting: Paint exposed metalwork in hoistway, except friction surfaces, with one coat of black metal paint. Paint machinery and control equipment with one coat of machinery enamel. Machine and motor housings are to be filled and rubbed smooth prior to painting.

8 Hoist Ropes: Traction steel, of size and number to ensure proper traction and an approved factor of safety. Ropes are to be completely free of any kind of displaced or broken wires.

23.2.5 Control System

1 Dumbwaiter operation is to be by 'call' and 'send' buttons mounted in corridor station. Momentary pressure on 'call' button is to bring car to that station. Arrival of car at station is to cause single stroke gong to sound and illumination of station lantern. When car door is closed, momentary pressure on 'send' button is to dispatch car to corresponding floor. Red jeweled 'in use' signal light at each station is to remain illuminated while car is in use or when door is open at landing. When 'call' button is depressed while car door is open, a buzzer mounted on bottom of car is to sound.

2 Controller is to be located in machine space, unless otherwise approved by the Engineer. Switches and relays are to be mounted on insulated panels secured to self-supporting steel frame and enclosed in steel enclosure with hinged doors.

23.2.6 Electrical Equipment

1 Provide all wiring from main line disconnect switch to controller, and all signal
wiring and travelling cable from hatch junction box to car light. Travelling cable is to be flexible type, suspended and anchored to reduce strain on cables.

23.2.7 Loose Equipment, Spare Parts and Accessories

1 Supply loose equipment, spare parts and accessories as required for normal operation and routine maintenance of the dumbwaiter and as detailed by the Contractor in his offer for spare parts and accessories.

23.3 EXECUTION

23.3.1 Installation

1 Assembly: Equipment is, as far as possible, to be factory assembled, wired and tested. Site work is to be limited to installation and assembly of parts dismantled at factory for transportation, or otherwise to work not possible at factory.

2 Comply with manufacturer's instructions and recommendations.

3 Workmanship: Carry out work in a neat, workmanlike and efficient manner in accordance with the specified requirements. Installation is to be performed by skilled personnel specialized in dumbwaiter installation, who are in the permanent employment of the manufacturer or manufacturer's authorized dealer.

4 Accessibility: Install equipment so that it is readily accessible for operation, maintenance and repair.

5 Builder's Work: Carry out all builder's work necessarily required in connection with installation of dumbwaiters, including but not limited to cutting or forming chases, rebates, etc., grouting, concrete work, supports, steelwork, scaffolding, etc. Provide convenience power, lighting and other services required from assigned terminal points, to carry out construction work.

6 Coordination: Coordinate equipment installations with building construction to prevent alteration to structure and cutting of holes and chases after equipment installation has started.

7 Shaft Wall: Ensure that shaft wall facing open car entrance is in same vertical plane as face of landing door and that whole face is perfectly smooth. Gap between shaft wall and car door sill is not to exceed 10 mm for whole length of shaft.

8 Fixing Guide Rails: Keep rails in proper alignment using steel splice plates of adequate strength. Verticality of rail is to be within 0.2% tolerance. Space fixing brackets to minimize rail vibration during operation, and at not more than 2 m centers.

9 Painting: Protect metalwork by painting. Painting is to include thorough cleaning of metal, application of rust inhibiting prime coat and two finishing coats of approved enamel. Exposed steel parts of car, landing doors, frames and inside walls of car and landing architrave are to be painted with three coats of enamel, each sanded smooth before application of next coat, to achieve a perfect finish.
10 Alignment: Coordinate hoistway doors with dumbwaiter travel and car positioning for accurate alignment and minimum clearance between car, hoistway doors, sills, and door frame at each landing. Adjust car stops for accurate leveling of car at each landing, within specified tolerances.

11 Set sills flush with finished surface of floors or counters. Fill space under sills solidly with non-shrink, nonmetallic grout.

12 Lubricate operating parts of dumbwaiter, including wire ropes, guide rails, door tracks, and hardware.

23.3.2 Inspection and Tests On Site

1 Tests: After installation is complete and prior to Substantial Completion, carry out all tests required by the Governing Codes. Carry out any other tests the Engineer may require to check compliance of installation with the specified requirements. Tests are to be witnessed by the Engineer and, if required, by the authorities having jurisdiction.

2 Equipment Failure: Repair and make good any damage to equipment caused by tests, or damage to building caused by failure of any part of the installation, to the satisfaction of the Engineer.

3 Organization of Tests: Provide all labor, materials and instruments required for tests.

4 Test-operate dumbwaiter continuously between lowest and highest landings served, hoisting full-rated capacity load for a minimum of 30 minutes. Readjust car stops and other devices and signal equipment for accurate landings and operation of system after completing test.

23.3.3 Demonstration

1 Engage a factory-authorized service representative to train Employer's maintenance personnel on procedures and schedules for maintaining, operating, adjusting, troubleshooting, and servicing dumbwaiters.

23.4 DUMBWAITER SCHEDULE

1 Dumbwaiter No:

(a) Load: 50 kg.
(b) Speed: 0.4 m/sec.
(c) Number of Starts per Hour: 100
(d) Position of Machine: Above
(e) Power Drive: Electric Motor
(f) Control System: Call and send Operation Mode
(g) Floors Served: Ground Floor, First Floor
(h) Door Type: Bi-Parting
(i) Main Parking Floor: Ground Floor
(j) Car Platform Size: 0.6m wide x 0.6m deep.
(k) Door Opening: 0.6m x 0.75m
(l) Shaft Dimensions:
   a. Width: 1.0 m.
   b. Depth: 0.75 m.
   c. Construction: Concrete.
(m) Electric Power Supply: AC 240V, 50 Hz.
(n) Height of Counter Above Finished Floor Level: as per architecture drawings.
(o) Finishes:
   a. Car:
      1) Walls: Brushed Stainless steel
      2) Sills: Brushed Stainless steel
      3) Ceiling: Brushed Stainless steel
      4) Flooring/Bottom Counter: Brushed Stainless steel
   b. Control and Signals Brushed Stainless steel bevelled edge
   c. Controller: Brushed Stainless steel
   d. Architrave and General Trim: Brushed Stainless steel
   e. Doors: Brushed Stainless steel
30. **BUILDER’S WORK**

30.1 **GENERAL**

1. Materials and Workmanship, unless otherwise specified, are to be in accordance with the relevant requirements of the Specification for Structural and Architectural work.

2. Description of Work: cable and duct trenches, equipment foundations, bases and supports, ducts and duct banks, chases, holes and the like, sleeves, bolts, brackets and fixings including grouting.

3. Confirm locations and dimensions of all builder’s work required for electrical work. Submit shop and construction drawings or other data to the Engineer for checking before proceeding with the work.

4. Agree precise locations of routes for services below ground with the Engineer, set out clearly and accurately and locate with temporary marker posts.

30.2 **PRODUCTS AND MATERIALS**

30.2.1 **Components**

1. Un-Plasticized Polyvinyl Chloride (uPVC) ducts for outdoor power and lighting cable installations are to be non-sparking type, suitable for direct burial in ground, minimum tensile strength 500 kg/cm², impact strength 5 kg/cm², supplied in standard 6m lengths, with one end of each length tapered. Ducts are to be nominal size shown on the drawings, with minimum wall thickness 3.2 mm for 100 mm ducts and 4.7 mm for 150 mm ducts.

2. Duct supports are to be pre-formed, non-metallic of approved type. Supports containing metal are to have the metal non-continuous and not forming a magnetic loop in any manner.

3. Covers for trenches in electrical rooms and the like, unless otherwise specified or shown on the Drawings, are to be flanged chequered steel plates with angle or channel-section frames, suitably reinforced to support anticipated loads, and finished with zinc chromate primer and two coats grey enamel.

4. Brackets, supports, rails and tracks for supporting electrical installations are to be galvanized steel, fixed with expansion bolts of approved size and material. Plastic inserts and lead anchors are not acceptable unless approved for specific light duty installations.

30.2.2 **Composite Construction**

1. Equipment Foundations and Bases are to be constructed of reinforced concrete, as approved by the Engineer after submission of design calculations. Dimensions, levels and surface finishes are to be suitable for equipment installed, as shown on the Drawings or in accordance with approved shop and construction drawings.

2. Concrete Envelope for Duct Banks for power distribution systems and outdoor lighting cable installations crossing water, gas and sewage mains, under
roadways and where required or shown on the Drawings, is to be reinforced concrete Class C50 using moderately sulphate resisting cement, ASTM C150 Type II for the sites. Reinforcement is to consist of 12 mm diameter longitudinal bars at approximately 300 mm centers along bottom and sides of duct bank with 10 mm diameter U-shaped transversal bars at 400 mm centers. Length of concrete envelope is to extend at least 300 mm beyond each side of crossing etc.

30.3 WORKMANSHP

30.3.1 Generally

1 Cable Trenches width is to be as small as practicable with sides vertical. Remove mud, rock projections, boulders and hard spots from trench bottom and trim level. Inform the Engineer in advance to give him reasonable opportunity to inspect trench for each section of the work.

2 Directly Buried PVC Cable Ducts:
   (a) Lay and joint ducts to required line and level on sand bed, cover with sand and backfill trench to ground level with excavated soil, free from stones and other debris, well compact in layers not exceeding 300 mm thick.
   (b) Lay approved concrete tiles to fully cover cable duct, extending minimum 50 mm beyond sides of duct and placed 300 mm below ground level.
   (c) Provide warning tape or galvanized steel mesh along duct runs at a depth of 200 mm below ground level.

3 Underground Cable Duct Assemblies:
   (a) Form duct assembly to required line and level, using duct supports spaced to prevent sagging of ducts and breaking of couplings and watertight seals, and secured with cords (not tie wires) where necessary.
   (b) Provide 1% slope to duct banks for draining to exterior manhole, handhole or other location as instructed.
   (c) Join ducts using waterproof cement, to manufacturer’s recommendations, to give waterproof and sand-proof joint with at least 80 mm overlap.
   (d) Provide 3 mm galvanized steel wire inside empty ducts, for future pulling of cables, extending 1 m beyond ducts banks at both ends and securely fixed to wooden bungs sealing the duct.

4 Ducts ending in cable manholes or handholes are to be neatly cut and reamed and set behind chamfered precast concrete duct end blocks or terminated with appropriate bell-mouth bushing set in concrete wall. Ducts not ending in cable manholes or handholes are to be properly capped.

5 Conduits and ducts, active or spare, at entry into building or manhole, are to be completely sealed with approved plastic moulds or wooden bungs to prevent entry of rodents, gas and vapour.

6 Sleeves or ducts in equipment foundations are to be provided, whether shown on the Drawings or not, and in accordance with approved shop and construction...
drawings or as instructed by the Engineer. Obtain approval of sleeve or duct installation prior to concreting.

7 Support Frames for Switchgear/Switchboards located over cable trenches, where shown on the Drawings or required by equipment design, are to be installed prior to concreting.

8 Drilling for anchor bolts is to be carried out using appropriate electric drills and in approved positions.

9 Holes and chases in in-situ concrete are to be cast in. Do not cut hardened concrete or drill holes larger than 10 mm diameter without prior approval.

10 Do not cut or drill precast concrete without prior approval.

11 Do not cut or drill structural steel work without prior approval.

12 Holes and chases in masonry must not exceed:
   (a) Size of holes : 300 mm square
   (b) Depth of vertical chases : 1/3 wall thickness or, in cavity walls, 1/3 leaf thickness
   (c) Depth of horizontal chases : 1/6 wall or leaf thickness.

13 Cutting masonry:
   (a) Ensure mortar is fully set before commencing.
   (b) Cut carefully and neatly, avoiding spalling, cracking or other damage to surrounding structure.
   (c) Keep holes to smallest practicable size and do not exceed specified dimensions.
   (d) Cut chases in straight lines and horizontally and vertically only. Do not set back to back; offset by a distance not less than wall thickness.

14 Submit proposals for bridging over holes for ducts etc. which exceed 460 mm width.

30.3.2 Inspection and Cleaning

1 Directly buried ducts and underground duct assemblies are to be inspected in the presence of the Engineer, before backfilling or concreting. Steel mandrel or other approved device, diameter equal to 90% of inside diameter of duct and 500 mm long, is to be pulled through entire run of duct and is to pass through without getting stuck. Ducts which do not allow mandrel to be pulled through are to be repaired or replaced to the satisfaction of the Engineer.

2 Clean ducts with stiff bristle brush pulled through each duct prior to pulling in cables.
31. POWER DISTRIBUTION TRANSFORMERS

31.1 GENERAL

31.1.1 Scope

1 This part specifies the requirements for Power Distribution Transformers.

31.1.2 Description

1 Power Distribution Transformers shall be provided as specified.
2 Work shall include, but not limited to:
   (a) Interconnecting power and control cabling and ancillary works.
   (b) Connection to BMS system, including interface elements.

31.1.3 References

1 Power Distribution Transformers shall be provided in accordance with latest International Standards referred to therein.

31.1.4 Submissions

1 Tender information and drawings shall be submitted to QGEWC for approval. Submissions shall be in accordance with QGEWC requirements. Approval is to be obtained prior to equipment procurement.

31.1.5 Quality Assurance

1 Manufacturer Qualifications: Engage a firm experienced in manufacturing transformers similar to those indicated for this project and with a record of successful in-service performance.
2 Installer Qualifications: Transformer to be installed, tested and commissioned by experienced, technically trained and skilled personnel from qualified agency, certified by the manufacturer/authorized representative.
3 Local Representative: Provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy the Engineer may disqualify a manufacturer.
4 Standards: equipment and component parts are to comply with the following Standards:
   (a) IEC 60694: Common clauses for HV switchgear and control gear standards.
   (b) IEC 60076, 60354, 60726, 60905: Power transformers.
   (c) IEC 60726: Dry type die cast resin.
   (d) IEC 60076-8: Application guide for Power Transformers.
(e) IEC 60137: Bushing for Transformers.
(f) IEC 60529: Degrees of protection provided by enclosures (IP Code).
(g) IEC 60044-1, 60186: Instrument transformers.
(h) BS 2562: Cable Boxes for transformers and reactors.
(i) BS 6121: Mechanical cable glands.
(j) BS EN 50262: Metric cable glands for electrical installations.

5 All transformers shall be suitable for normal operation at 50 deg. C (122 deg. F) ambient temperature.

6 Warranty: Provide 2 years warranty from date of commissioning for all equipment specified in this Section.

7 Factory Tests: Design tests (type tests), special tests, and routine tests to conform to referenced standards.

8 Factory Tests Witnessing: Conduct routine tests, special tests and type tests on equipment for this Project for witnessing by Engineer. However, these special tests and type tests need not be repeated if the manufacturer submits satisfactory test reports/certificates, acceptable to the Engineer, on tests conducted previously on identical transformers.

9 The Transformers shall be designed to ensure satisfactory operation in indoor environment under site and system operating conditions as per QGEWC documents.

31.2 PRODUCTS

31.2.1 General

1 Contractor shall supply, install, test and commission Power Distribution Transformers as specified.

2 The transformers shall be of the dry type.

3 Contractor shall be responsible for obtaining QGEWC approval.

4 The product selected and proposed shall include manufacturer’s instructions that indicate application conditions and limitations of use stipulated by the product testing agency specified under Regulatory Requirements.

5 Contractor shall provide full technical details of the proposed transformers together with a copy of all relevant standards for review and comment by the Engineer, prior to submission to QGEWC for approval.

31.2.2 Dry Type Cast Resin Power Transformer

1 The following classification of dry type transformers (Environmental, Climatic & Fire) according to CENELEC are to be considered. Classification is to be certified by an approved, independent testing agency, in accordance with the relevant IEC / CENELEC.
(a) Environmental: E2 Consistent condensation or server pollution condition or combination of the two phenomena. These two conditions may occur in outdoor installation.

(b) Climatic: C1 Indoor installation. The transformer is suitable for operation at ambient temperatures not below -5 deg. C but may be exposed during transport and storage to ambient temperature down to -25 deg. C.

(c) Fire: F1 Transformers subject to Fire hazard. Restricted flammability is required. Self-extinction of Fire (poor burning is permitted with negligible energy consumption) shall take place within a specified time period. The emission of toxic substances and opaque smokes shall be minimized. Type test certificates for F1 Fire classification shall be submitted along with the transformers offer.

2 Type: 3-phase, indoor, 2-winding, solvent less cast epoxy resin, vacuum pressure impregnated windings, with minimum class F insulation on inner MV cores and class F on outer HV cores, rated for continuous operation under worst site ambient conditions at full load, and complying with IEC 60726. all transformers shall be suitable for normal operation at +5 deg. C (122 deg. F) ambient.

(a) Core:

(i) The core shall be constructed from high grade non-aging cold rolled, grain oriented silicon steel laminations as a minimum requirement.

(ii) All parts of the core shall be of robust design capable of withstanding any shocks to which they may be subjected during lifting, transportation, installation and service.

(iii) The magnetic circuit shall be earthed through a link as specified in clause Internal Earthing.

(b) HV Windings:

(i) The high voltage winding shall be wound with copper conductor material and encapsulated in glass fibre or quartz reinforced epoxy-resin. The casting of the transformer shall be self extinguishing fire proof and shall be interconnected by interconnection pieces with similar insulation or by other approved method. HV windings will be separated from the MV windings to give an air gap between the HV and MV circuits in order to avoid depositing of dust on the spacers placed in the radical electrical field and to make maintenance easier.

(ii) Tappings shall be arranged at such positions on the HV Winding that will preserve, as far as possible, the electromagnetic balance of the transformer at all voltage ratios, but shall also be positioned with due regard to the impulse voltages which may be impressed on the windings.

(c) MV windings: Medium voltage windings shall be wound with copper conductor material, encapsulated in glass fiber or quartz reinforced epoxy-resin and provided with appropriate terminals for direct connection to the cable box.

3 Insulation and Encapsulation: Humidity resistant, explosion and fire-resistant, self-extinguishing, tropicalized, non hygroscopic, giving non-toxic gases in the event of fire.
4 7 equal tappings are to be provided on HV side by means of reconnectable links (off-circuit) (3 tappings above and three tappings below the rated MV side), giving +/-2.5 percent step tapping on transformers.

(a) Voltage Control:

(i) The transformer shall be provided with manual variation of the transformation ratio by means of tappings which can be selected whilst the transformer is off-circuit. Tapping selection shall be by means of links which shall be secured by Allen Head Screw. 1 No. Allen head key shall be supplied with each transformer. The means of tapping selection shall be provided with means of locking.

(ii) The variation shall take place over the range, without producing phase displacement.

(iii) The taps shall be so arranged with the connection links or bridges that in no case can taps be short-circuited.

(iv) Each tap terminal shall be marked with a number corresponding to the number for that tap position as shown on the rating and diagram plate mounted on the transformer.

(b) Access for Links:

(i) Primary voltage selection links and tap selection links shall be located at a convenient height. The design shall be such that these links will be easily accessible by an operator after opening the enclosure cover once the transformer is installed at site and all cables are connected.

(ii) A connection and terminal marking diagram shall be provided for easy reference for tap changing/voltage selection.

5 Rubber sound isolation Pads are to be provided between core and coil assemblies, and between base and housing.

(a) Mounting and Handling: Transformer base and structure are to have lifting hooks or lugs, towing and lashing eyes or lugs and provision for roller wheels.

(b) Temperature monitoring is to be provided by externally mounted tripping units giving alarm and trip at two stages with about 20 deg. C (68 deg. F) temperature difference, actuated by three embedded thermistor sensors in MV windings (hot-spot). Additional thermal monitoring/control is to be provided for cooling fan operation.

(c) High temperature alarm monitoring is to have a built-in digital display unit.

(d) Temperature Indicator.

(i) The preferred temperature sensing device would have a positive linear characteristics and be molded into the MV coil or coils to measure the hot spot temperature. The manufacturer would determine and select the point of measurement. Other methods are subject to the Engineer’s approval.

(ii) The sensing device would be used in conjunction with a digital indicator which would continuously display the actual temperature and also indicate the highest temperature reached. The highest temperature indication shall be retained until it has been reset by hand. It shall be possible to reset the indicator without opening the
(iii) Test certification for temperature indicator shall be provided.

(e) Temperature alarm is to be monitored by the BMS.

(f) Terminals: Arranged as described in the Specifications or as shown on the Drawings, and are to be compatible for copper or aluminum cable termination.

(g) Earthing bolts or copper pads are to be provided on main frame of transformer. Earthing busbars are to be provided on MV and HV sides of housing.

(h) Housing: Sheet steel construction, IP 21 for indoor installation.

(i) Openings shall be provided on the enclosure for access to the voltage selection links and tap selection links. These openings shall be provided with sliding or hinged or removable type covers made from the same material as of enclosure. It shall be possible to lock the covers by means of Allen Head Screws or other suitable means. Number of screws shall be a minimum preferably not more than 2.

(ii) Each transformer shall be provided with one Allen Head Screw or special tool required to open these access covers.

(iii) A skid under base shall be provided for the complete unit (i.e. transformer and enclosure). The skids shall be parallel to the long sides of the enclosure.

(iv) Transformer enclosure shall be made rodent-proof.

(v) All bare terminals shall be suitably shrouded.

(i) Characteristics:

(i) Rated power: as shown on drawings.

(ii) Frequency: 50 Hz.

(iii) Rated voltage:

- HV side (primary): 11 kV
- MV side (secondary): 415 kV

(iv) Winding connections: DyN 11 neutral insulated and brought out.

(v) Impedance voltage at rated current: 6 percent.

(vi) Rated power frequency withstand-voltage: 28 kV.

(vii) Duration of short-circuit-withstand: 2 seconds.

(viii) Terminal connection system:

- HV side: Cable sealing ends, bolted.
- LV side: Cable glands and fittings, bolted.

(j) Accessories are to include the following:

(i) Earthing switch, fault-making type, on HV side of housing, interlocked with door, visible from outside the enclosure, with trip contact for tripping HV circuit breaker before closing earthing switch.

(ii) Restricted-Earth-Fault relay with certification from manufacturer. A CT shall be provided on the neutral of the transformers for REF
(iii) Metal Nameplate with all ratings clearly embossed as per requirement of IEC and clearly indicating, the country of origin, fixed with metal screws/rivets, at a prominent position on the body of the transformer.

(iv) 4 re-orientable roller rim wheels and attachment accessories.

(k) Current transformers (CTs): dry type (cast-resin), with the following characteristics:

(i) Metering (general): Class 1, 5A secondary.
(ii) Protection: 5 P15, 5A secondary.
(iii) Kilowatt-hour: class 0.5.
(iv) Rated primary current, core size and accuracy limit factor are to be determined in accordance with nominal current of plant protected, short-circuit level and burden. CT is to perform under specified conditions without exceeding accuracy limit. Submit error curves for approval. Thermal short-circuit rating is to be 100 times rated primary current, with dynamic short-circuit rating of 2.5 times thermal rating.
(v) Type test certification from approved, independent testing laboratories such as ASTA/KEMA to be furnished.
(vi) Routine test result certification from manufacturer.

(l) Voltage transformers (VTs): Magnetic, single-phase, indoor, dry type (cast-resin encapsulated), with the following characteristics:

(i) Rated voltage:
   Primary : 11 kV.
   Secondary : 100 V.
(ii) Accuracy class : 0.5.
(iii) Rated voltage : 1.2 continuous.
(iv) Factor : 1.9 for 30 seconds.
(v) Check associated burden and ensure VT can perform satisfactorily under specified conditions. Submit error curves for approval.
(vi) Type test certification from approved, independent testing laboratories such as ASTA/KEMA to be furnished.
(vii) Routine test certification from manufacturer.

(m) Internal Earthing

(i) General: All non-current carrying metal parts of the transformer with the exception of the individual core laminations, core bolts and associated individual clamping plates shall be maintained at ground potential.

(ii) Earthing of Core Clamping Structure: The top main core clamping structure shall be connected to the enclosure by a copper strap. The bottom main core clamping structure shall be earthed by a method of proposed by the manufacturer and approved by the Engineer.

(iii) Earthing of Magnetic Circuit: The transformer core shall be insulated from the structure so as to withstand core insulation tests specified in
this specification and subsequently be earthed through a detachable flexible copper link.

(n) External Earthing:
   (i) Earthing Terminals shall be adequately dimensioned (not smaller than 12 mm diameter stud) to receive the external earthing conductors. Provision shall be made at positions close to each of the bottom four corners of the enclosure for these connections.
   (ii) Earthing terminal/bar to be clearly and prominently labeled and located at an easily accessible location.

(o) HV Termination:
   (i) HV Termination shall comprise 3-pole air insulated cable box suitable for either top or bottom entry of HV cable as per the requirements of the particular installation.
   (ii) The cable gland plate of the cable box shall be removable and shall be fitted with a suitable gland for the HV cable. The minimum clearance between room floor level and the gland shall be 100mm.
   (iii) The number of nuts/studs to be unscrewed for the removal of cable box shell/cover shall be kept to a minimum.
   (iv) Lead length from the gland to the centre phase terminal of cable box shall be minimum 450mm and for the other two phases shall be maximum 500mm.
   (v) Provision shall be made for earthing the body of cable box by a flexible copper not less than 95 sq. mm to the earth bond of the equipment. Provisions shall also be made for connection/earthing of armor wires of the cable.
   (vi) The bushings shall be without skirts suitable for application of cold shrink boots.
   (vii) The cable box shall be mounted on one of the long sides of the transformer enclosure at a height convenient for cable termination.
   (viii) Provision shall be provided on the bushing terminals for connection of crimping type copper cable sockets (lugs), suitable for the above cable.
   (ix) The connection from the HV windings to the HV Cable box shall be flexible in compliance with Class 6, Table-IV of IEC 60228 to allow for any expansion and contraction in the transformer core and coils and also to withstand vibrations and shocks without damage during transport. These connections shall be fully insulated and supported in a manner to withstand short-circuits. A sample of the cable shall be submitted by the Contractor along with the Drawings for the Engineer's approval.

(p) MV Termination:
   (i) The MV Termination shall comprise 4 pole air insulated cable box with detachable gland plate, complete with brass compression glands for receiving and terminating cables from either above or below or busduct system.
   (ii) Provisions shall be provided on the bushing terminals for connection
of crimping type cable sockets (lugs) suitable for the MV cables.

(iii) The MV neutral shall be brought out through a separate bushing within the cable box and shall comprise of a detachable neutral to earth link with a separate earthing terminal to receive two nos. of bare copper flat of 25 mm width and 3 mm thickness. Size of the neutral to earth link shall be at least 150 sq. mm. The neutral earthing bushing shall be mounted on the bottom plate of the cable box.

(iv) Gland plate for single core cables shall be made of non-magnetic material.

(v) MV cable box shall be mounted on the enclosure on the opposite side to the HV cable box.

(q) Auxiliary Contacts For Monitoring:

(i) Wiring and Terminal Block: Auxiliary contacts provided for remote monitoring of temperature and load (current) shall be wired to a common terminal block.

(r) Inflammable or toxic fume generating materials, such as wood, Bakelite, plastic, etc. shall not be used within the transformer enclosure.

(s) In general, all fixing screws, bolts for covers and plates shall be of “captive” type, which does not fall off when fully loosened.

31.3 INSTALLATION

31.3.1 General

1 Locations and Layout: Exact locations and physical layout of equipment and components may be varied as required to suit manufacturer's design and as approved, provided the required functions and operations are accomplished; follow the identification of the units indicated on the Drawings exactly to ease checking and building maintenance procedures.

2 Equipment Bases: Ensure that concrete bases and foundations where provided for installation of equipment are constructed in accordance with approved Shop and Construction Drawings and equipment manufacturers' drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required. Other installation provisions are subject to the Engineer's approval.

3 Cable Trenches: Ensure that trench construction and covers where provided for installation of power and control cables are in accordance with approved Shop and Construction Drawings.

4 Built-In Items: Ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which are to be built into concrete foundations, bases, cable trenches or building structure are provided as and when required and that they are properly installed.

5 Equipment: Assemble completely plumb and level, before grouting in holding-down bolts.

6 Supports and Terminations: Install all incoming and outgoing cable supports, cable ends and termination fittings required for HV, MV and control cables.
7 Relays: Set in accordance with manufacturer's instructions and the network’s requirements.

8 Earthing: Ensure that earthing installation is as described under Part 22 of Section 21 of the Specification and/or as shown on the Drawings.

9 Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

10 Installation to be certificated by manufacturer/manufacturer’s authorized representative, and to comply with IEC.

11 Cable Clamps: Cable clamps shall be provided on the transformer enclosure to support rising run of both HV and MV cables from trench to the cable boxes. Cable clamps for Single Core MV cables shall be made of non-magnetic material.

12 Re-confirm that space clearance exists to remove and replace the transformer, without disturbing or moving other equipment.

13 Ensure cable trench covers are suitably cut / modified to suit cable entry and rubber gaskets are provided at all cut edges to prevent damage to transformer cables.

31.3.2 Identification

1 Identification transformers and install warning signs per Section 21 requirements.

2 Format shall be as per IEC 60726.

31.3.3 Connections

1 Tighten bus joint, connector, and terminal bolts according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

31.3.4 Field Quality Control

1 Manufacturer’s Field Services: Arrange and pay for the services of a factory-authorized service representative to supervise the field assembly, connection of components, testing and commissioning of the transformer.

2 Equipment: Inspect equipment upon delivery to site and report any damage to the Engineer.

3 Components: Check component ratings, types, sizes and wiring connections, including current and voltage transformers, fuses, switches, instruments and relays.

4 Manufacturer's instructions are to be followed under all circumstances. Carry out and record measurement and tests recommended by the manufacturer.

5 Test Objectives: To ensure transformer is operational within the specified industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.
6 Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed "Satisfactory Test" label to tested component.

7 Schedule tests and provide notification at least 7 days in advance of test commencement.

8 Report: Submit a written report of observations and tests. Report defective materials and installation.

9 Tests: Include the following minimum inspections and tests according to manufacturer's written instructions.

(a) Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers for dry-type transformers.

(b) Inspect bolted electrical connections for tightness according to manufacturer's published torque values.

(c) Insulation Resistance: Perform meg-ohmmeter tests of primary and secondary winding to winding and winding to ground.

(d) Duration of Each Test: 10 minutes.

(e) Temperature Correction: Correct results for test temperature deviation from 20 deg C (68 deg. F) standard.

(f) Turns Ratio: Measure between windings at each tap setting. Measured ratios deviating more than 0.5 percent from calculated or measured ratio for an adjacent coil is not acceptable.

(g) Winding Resistance: Measure for windings at nominal tap setting. Measured resistance, deviating more than 1 percent, from that of adjacent windings, is not acceptable.

(h) Vector group test shall be carried out.

(i) All the testing procedures shall comply with IEC requirements.

10 Field test reports to be certified by manufacturer/authorized representative as "acceptable and fit for energization".

11 Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

12 In addition to the above, Transformer energisation shall be carried out only after the following are certified acceptable:

(a) Relay coordination "up-stream".

(b) Fire alarm system.

(c) BMS monitoring.

(d) All lighting including emergency lighting.
(e) All civil works in the room and complete cleaning.

(f) Locking facility for the room.

31.3.5 **Grounding**

1 Comply with Section 21, Part 22 and installation requirements.

31.3.6 **Cleaning**

2 On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

31.3.7 **Adjusting**

1 After installing and cleaning, touch up scratches and mars on finish to match original finish.

2 Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

31.3.8 **Demonstration And Training**

1 Engage a factory-authorized service representative to explain transformers and accessories and to train the Employer's maintenance personnel. Include a minimum of 8 hours of training in operation and maintenance. Provide both classroom training and hands-on equipment operation covering the following:

   (a) Safety precautions.
   (b) Features and construction of project transformers and accessories.
   (c) Routine inspection, test, and maintenance procedures.
   (d) Routine cleaning.
   (e) Features, operation, and maintenance of integral disconnect switches and protective devices.
   (f) Interpretation of readings of indicating and alarm devices.
   (g) Fuse selection.
   (h) Protective-relay setting considerations.
   (i) Features, operation, and maintenance of separable, insulated, connector system.
   (j) Tap-changing procedures.

2 Schedule training with the Employer with at least 7 days' advance notice.
Add the following completely new Part titled: Part 40 – Video Surveillance System including its associated table of contents and new clauses as follows:

40. VIDEO SURVEILLANCE SYSTEM

40.1 GENERAL

40.1.1 Related Documents

1 Contract

(a) Drawings and general provisions of the Contract, including Conditions of Contract and Specification sections, apply to this Section.

(b) In particular, refer to these documents for all elements related to costs and responsibility related to delivery, storage, and roll-out phase.

40.1.2 Definitions

1 AC: Access Control.

2 CCD: Charged Coupled Device.

3 CCTV: Closed Circuit Tele Vision.

4 CU: Control Unit.

5 EMI: Electromagnetic Interference.

6 EN: European Standard.

7 FCC: Federal Communications Commission.

8 FTP: File Transfer Protocol.

9 GUI: Graphical User Interface.

10 HMI: Human Machine Interface.


12 IP: Internet Protocol.


14 LAN: Local Area Network.

15 MTTR: Mean Time To Repair.

16 MTBF: Mean Time Between Failures.

17 MOI: Ministry Of Interior

19 NMS: Network Management System.
20 PTZ: Pan, Tilt, Zoom Camera.
21 QoS: Quality of Service.
22 SCN: Structured Cabling Network.
24 SMTP: Simple Mail Transfer Protocol.
25 STP: Shielded Twisted Pair (some refer to this item as FTP: Foil-shielded Twisted Pair).
26 SLA: Service Level Agreement.
27 UL: Underwriters Laboratories.
28 UPS: Uninterrupted Power System.
29 UTP: Unshielded Twisted Pair.
30 VLAN: Virtual LAN.
31 VPN: Virtual Private Network.
32 WAN: Wide Area Network.

** Employer throughout the specifications refers to Public Works Authority (PWA).

** Operator throughout the specifications refers to Primary Health Care Corporation (PHCC).

### 40.1.3 Summary

1 This Section includes the specifications for an IP Surveillance System including but not limited to IP Cameras, Software, Servers & Personnel Computers, Data Storage System and other equipment required to operate an IP Surveillance Network. All system components shall comply with MOI regulations and approved materials.

2 Objectives

   (a) The IP Surveillance System at the locations indicated on drawings is mainly used for:
   
      (i) Operation purposes,
      (ii) The monitoring of all vital areas,
      (iii) For the surveillance and to enforce safety and security (access control system),
(iv) For the general surveillance of the Employer's premises.

(b) The functions of the IP Surveillance System consist of:

(i) Facilitating the coordination of the operations,

(ii) Supplying staff with video information improving their conception of the premises at the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor.

(iii) Monitoring of entrances for the Access Control System as applicable,

(iv) Monitoring of zones for the Fire Alarm System,

(v) Recording and storage of images.

40.1.4 System Description

1 Purposes

(a) The present document is to describe the IP Surveillance active infrastructure to be installed as part of the Employer's IT systems.

(b) 25% spare capacity is required at all levels of the system.

(c) The software licensing shall be for the entire network with no limitation on the number of workstations or standard end-users.

2 Scope of Works

(a) The Scope of Works shall include, but not limited to, detailed engineering, coordination, manufacture, supply, transportation, delivery, installation, testing, commissioning, setting to work, training and maintenance services during the 24-month Warranty Period, Operation and Maintenance services (as an option to the Employer) for the IP Surveillance active infrastructure of the Employer's IT systems. This shall include at least the following tasks:

(i) Coordination with the Employer existing operators, contractors, and providers of interfaced systems,

(ii) Project management,

(iii) Planning management,

(iv) Detailed functional analysis until approval by the Employer,

(v) Finalization of system to the approval of the Employer,

(vi) Detailed software specification to the approval of the Employer,

(vii) Delivery of the interface control document to the approval of the Employer,

(viii) Software development, complying with the detailed software specification,

(ix) Supply of needed IP Surveillance equipment and components,

(x) Transport, unloading, and storage on the site of the required equipment and components,

(xi) Equipment installation,

(xii) Software installation,
(xiii) System installation and configuration,
(xiv) System integration with interfaced and existing systems (if any),
(xv) Complete testing of the system (unit tests, integration tests, final acceptance tests, users’ tests, etc.),
(xvi) Training,
(xvii) System implementation in the Employer’s premises,
(xviii) System roll-out,
(xix) System maintenance after successful initial proving period during Warranty,
(xx) Supply of spare parts for 2 years,
(xxi) System maintenance tools delivery,
(xxii) Writing and delivering of documentation (user’s manual, maintenance manual, test reports, etc.),
(xxiii) Operation and Maintenance as an option to the Employer.

(b) Technical specifications and architecture principles are generic and can be used to future extensions.

(c) The Contractor shall provide data cable (Cat 6A) between the IP Surveillance System and the horizontal floor distribution cross connect in the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor. Fiber Optic cable shall be provided when distance between camera and corresponding switch is exceeding 90m as recommended by manufacturers.

(d) The Contractor shall provide the necessary IP cameras, data network switches, network storage mangers, local workstations, patch panels, UPS one hour autonomy, fiber optic cables, Cat 6A copper accessories and ancillary, etc. for the complete operation and full integration of the above.

(e) The operator shall have the full control of these cameras from the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor. Local terminals and clients shall be provided in the concerned buildings for on-site operation and security monitoring.

(f) The Contractor shall fully coordinate with the Employer’s Representative for the exact location and positioning of the different equipment and materials.

(g) Specific Requirements:
(i) Integration with existing network elements, if any, with full responsibility to the Contractor in order to make a coherent IP Surveillance System. This work shall be carried out in close coordination with the Employer IT Department.

(ii) Manufacturer technical validation and endorsement of the design documentation and implementation shall be provided.

(iii) Risk analysis on the design with advantages and drawbacks will have to come from the Manufacturer.

(iv) Post deployment auditing by Manufacturers shall be specified in the documents,

(v) Submission of credential of the trainers shall be approved by the
Manufacturer and by the Employer.

(h) The Contractor shall be responsible for the provision of the licenses for all software, programs and modules provided for the Works including those developed and modified by the Contractor. The appropriate licenses supplied by the Contractor shall enable the Employer to use, modify, and develop the software, programs and modules for the works supplied under this Contract. The software licensing shall be for the entire campus with no limitation on the number of workstations or standard end-users.

3 Coordination

(a) Coordinate Works of this Section with the Employer’s:
   (i) Departments, operators, contractors, organization, etc.
   (ii) Construction and implementation works.
   (iii) Structured cabling network, both for technical room configurations and for connectors' type (electrical and optical).
   (iv) Active communication and data processing equipment.
   (v) Fiber optic cabling infrastructure.
   (vi) Workstations and servers suppliers.
   (vii) IT systems providers using the data network active infrastructure.
   (viii) Others (list given above not exhaustive).

(b) Meet jointly with representatives of above concerned organizations, contractors, and Employer’s Representative to exchange information and agree on details of project implementation, transition plan, equipment arrangements and installation interfaces, etc.

(c) Record agreements reached in meetings and distribute record to other participants.

(d) Adjust arrangements and locations of equipment and way of wiring closets to accommodate and optimize arrangement and space requirements.

4 Variant and Options

(a) The Contractor should propose no variant.

(b) Options consisting in additional provisions to the basic system may be submitted to the Employer for approval, with specifications, characteristics, aiming and full particulars of calculations and equipment selections. All options shall be priced separately.

5 Operational Constraints

(a) The system will run 24 hours per day, all the days of the year.

40.1.5 Submittals

1 Design Submission: Shall include, but not limited to:

(a) Equipment Datasheets must include (at least) the following information:
   (i) Product performance and existing features,
(ii) Environment requirements (Power, temperature, etc.),

(iii) Features, software and hardware releases roadmap on the next two years,

(iv) Standardized tests passed and results and available product certificates,

(v) Product compatibility matrix with other manufacturers/vendors (specify level of testing in operation, lab test, declarative or theoretical),

(vi) MTBF.

(b) System Requirement and Design Specification

(i) System Architecture and justification.

(ii) Justification of performance requirements.

(c) Management software datasheets must include (at least) the following information:

(i) Product performance and existing features,

(ii) Known limitations (number of network elements managed, number of administrators, number of clients, size of the database, etc.),

(iii) Hardware requirements (storage, computation, processor needs, operating system, display, etc.),

(iv) Features and software releases for the next two years,

(v) Standardized tests passed and results and available product certificates,

(vi) Product compatibility matrix with other manufacturers/vendors (specify level of testing in operation, lab test, declarative or theoretical).

(d) Installation, configuration, integration and support offers must detail:

(i) Level of qualification of the personnel involved. Detail if some parts shall be subcontracted.

(ii) Training program provided by the Manufacturer to the Contractor teams and related certificates.

(iii) Project structure and localization during operations (distinguish local and remote teams).

(iv) Detailed responsibility matrix for a task by task responsibility assignment.

(e) Technical documentation and troubleshooting guides shall be provided in English, both paper and electronic version, for each type of equipment in the offer.

(f) Product Certificates: signed by Manufacturers certifying that products furnished comply with requirements.

(g) Human Machine Interface (HMI) Design:

(i) For dedicated Workstation users.

(ii) For standard end users.
(h) Software Requirement and Design Specification:
   (i) Software Architecture and justification (e.g.: off-the-shelf and specific software, etc.).
   (ii) Justification of performance requirements.

(i) Test Plan:
   (i) The Contractor shall provide Test Plan on the testing methodologies used for various tests involved throughout different stages of the Works. This shall also include the plan for integrated tests for interface with other systems. The Contractor shall submit the Test Plan for approval by the Employer's Representative.
   (ii) Test program shall be part of the test plan.
   (iii) In establishing the test program, the Contractor and the Employer’s Representative shall agree which activities shall be attended by the Employer’s Representative.
   (iv) After approval, the Test Plan shall be amended as required during the life of the Project to reflect changes in system design and the identification of additional testing requirements.

(j) Maintenance and Warranty offers must detail:
   (i) Comprehensive cost structure according to committed GTI, GTR and MTBF.
   (ii) Maintenance stock dimensioning.
   (iii) Distinguish maintenance during warranty period and after.
   (iv) Teams’ organizations (distinguish local and remote teams, give associated manpower).
   (v) Hardware repairs and software patch support procedures.

2 Project Schedule

(a) Provide a detailed Build Plan that includes, but is not limited to:
   (i) All activities required to deliver a production ready system to the Employer.
      1) The duration of each activity in days,
      2) The resources required to complete each activity,
      3) Any dependencies amongst activities.

3 Product Data

(a) Include detailed Manufacturer's specifications and data sheets for each system component.

(b) Include data on features, ratings, and performance for each component specified.

(c) For each type of equipment, submit data for approval including catalogues and literature, sufficiently detailed for engineering purposes, and with full description of components and operating parameters.
4 Shop Drawings

(a) Indicate layout, wiring diagrams, and dimensions.
(b) Locate devices and components on drawings.
(c) Submit drawings for approval including, but not limited to, the following:
   (i) Detailed system schematic diagram,
   (ii) Layout of system components, management system, etc.
   (iii) System labeling schedules, including electronic copy of labeling schedules in software and format selected by the Employer’s Representative.
(d) Complete electrical and physical characteristics of system components, management system, etc.
(e) Complete system wiring diagrams, size and type of cables, enclosures, and terminal, splice boxes etc., and routing plans of wiring system.
(f) Include dimensioned plan and elevation views of components. Show access and workspace requirements.

5 System Operation Description

(a) Include method of operation and supervision of each component and each type of circuit, and sequence of operations for manually and automatically initiated system inputs.
(b) Description must cover this specific Project; Manufacturer’s standard descriptions for generic systems are not acceptable.

6 Manufacturer’s Installation Instructions

(a) Provide Manufacturer’s installation instructions.
(b) Certificates signed by Manufacturers of equipment certifying that the provided products comply with contract specified requirements.

7 Product Certificates

(a) The Contractor shall provide certificates signed by Manufacturers of components certifying that the provided products comply with requirements.

8 Tests and Certificates

(a) Test Specifications as defined in the Test Plan shall be submitted for Approval.
(b) Submit complete certified Manufacturer’s type and routine test records, in accordance with the Standards specified in "Quality Assurance" Article.
(c) It shall specify test results for compliance with performance contract requirements.
(d) Include record of signal ground resistance measurement certified by the Contractor.
9 Field Test Reports
   (a) As specified in "On-Site Tests and Inspections" Article of this Section, the Contractor shall indicate and interpret test results for compliance with system description and performance requirements.

10 Qualification Data
   (a) For firms and persons specified in "Quality Assurance" an article shall be written to explain and demonstrate their capabilities and experience.
   (b) To include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by the Employer's Representative.
   (c) An experienced Contractor, which is an authorized representative of the Manufacturer, for both installation and maintenance purpose, is formally required for this Section.

11 Record (As-Built) Drawings
   (a) Complete wiring diagrams, including complete terminal strip layout and identification, and wire termination and tagging for all conductors.
   (b) Locations for all components installed and/or connected to under this Specification.

12 Sample Warranty
   (a) Copy of Manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.
   (b) Provide copy of sub-contractor's warranty certificates.
   (c) Provide Contractor's warranty certificates.

13 Maintenance Data
   (a) For products and systems, the Contractor shall include maintenance manuals.
   (b) The Contractor shall include data for each type of product, including all features and operating sequences, both automatic and manual.
   (c) The Contractor shall include user's software data and recommendations for spare parts and components to be stocked at Project site.

14 Test Equipment List
   (a) The Contractor is responsible for furnishing all test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system. The Contractor shall furnish test equipment of accuracy better than the parameters to be tested. The test equipment furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test.
40.1.6 Regulations And Standards

1 Rules

(a) The Works shall be conformed to requirements of referenced industry standards, applicable Sections.

(b) The Works shall be compliant with Local Requirements, applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Employer’s Representative, in writing.

(c) The Works shall be compliant with the MOI-SSD general standards of specifications for security surveillance system mainly annexes 1, 2 and 7.

(d) Conflict: Should an instance occur in this Specification and referenced Sections in which equipment, components, material or construction methods called for is less than minimum requirement of the referenced industry standards, rules, local regulation, etc., the Employer's Representative shall be immediately informed in writing. Consequent to the Employer's Representative's approval, supply the equipment, components, material and perform the work as through called for to minimum code standards.

2 Standards

(a) Standards to be used is the IEC or other equal and approved codes, taking into account that network cables with fitted accessories and connector and wiring have to be of fire rated type in accordance with all NFPA requirements codes.

(b) System components, parts, and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC).

(i) ISO/IEC 11801: latest edition regarding Information Technology and generic cabling for customer premise.

(ii) EIA/TIA 568, Commercial Building for Telecommunication Wiring Standard.

(iii) EIA/TIA 569, Commercial Building for Telecommunication Pathways and spaces.

(iv) EIA/TIA 606 for Telecommunications Infrastructure: this document provides the user with guidelines and choices of classes of administration for maintaining telecommunications infrastructure.


(vi) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.

(vii) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.

(viii) IEC 60331 part 11 & 12, Tests for Electric Cables under Fire Conditions.
(ix) IEC 60332 Tests on Electric Cables under Fire Conditions.

(x) IEC 60364-1 Electrical Installations of Buildings, Fundamental Principles, Assessment of General Characteristics, Definitions.

(b) Comply with the latest issue of several material and test standards, which have been developed and published by Institute of Electrical and Electronics Engineers (IEEE) for data communications industry, but not limited to:

(i) 802.1 – Network Management Group,
(ii) 802.2 – Logical Link Control Group,
(iii) 802.3 – Carrier Sense Multiple Access/Collision Detection Group,
(iv) 802.6 – Metropolitan Area Networking Group,
(v) 802.7 – Broadband Technical Advisory Group,
(vi) 802.8 – Optic Fiber Technical Advisory Group,
(vii) 802.9 – Integrated Voice and Data LAN Working Group,
(viii) 802.10 – LAN Security Working Group,
(ix) 802.11 – Wireless Networks.
(x) 802.12 – Fast Ethernet.

(c) Comply, as often as possible, with both ITU-T (International Telecommunications Union) recommendations and US standards. When standards are not compatible in both Europe and US (e.g. telecom interfaces SDH STMx vs. SONET OCx) detailed compatibility and interface availability shall be provided.

(d) Comply with the latest issue of several material and test standards, which have been developed and published by Network Equipment Building System (NEBS). Level 1, Level 2, and Level 3 are applicable to this Section:

(i) SR3580: NEBS: Criteria Levels.
(ii) GR-63-Core: NEBS: Physical Protection.
(iii) GR-1089-Core: NEBS: EMC and Safety.

(e) European Telecommunications Standards Institute (ETSI).

(f) Safety:

(i) UL 1950, 3rd edition.
(ii) EN 60950/IEC60950.
(iii) EN60825 Laser Safety (Class 1).

(g) EMI:

(i) FCC part 15 Class A, B.
(ii) EN55022 Class A, B.

(h) Immunity:

(i) EN-61000-4-2 ESD.
(ii) EN-61000-4-3 Radiated Immunity.
(iii) EN-61000-4-4 EFT.
(iv) EN-61000-4-5 Surge.
(v) EN-61000-4-6 Low-Frequency Common Immunity.
(vi) EN-61000-4-11 Voltage Dips and Sags.
(vii) EN-61000-3-2 Power-Line Harmonics.

(i) NFPA 70: National Electrical Code.

3 Precautions

(a) The above list is a partial list issued from standard organizations. Additional consideration may be required to provide protection of equipment and protection of data from intrusion, induced noise or other events that can disrupt vital operation.

40.1.7 Quality Assurance

1 Requirements

(a) All Works shall be executed and controlled by a quality management system in accordance with the requirements of ISO 9001.

(b) This system shall comprise all the participants to the Contract within the Contractor's teams and its sub-contractors.

(c) The Quality Assurance Plan shall be based on quality manuals of the Contractor and sub-contractors.

(d) The Contractor shall nominate from the beginning of the Project, the person in charge of quality assurance of the whole project, who is directly linked to the Project Director.

(e) The Contractor should establish from the beginning of the Project, the Quality Assurance Plan based on Contractor's quality system that should define:

(i) Scope of Quality Assurance Plan, with conditions of validity and revision,

(ii) Approach and structure of the Contractor's quality management system to fulfill the requirements of the Contract and ISO 9001,

(iii) Organization retained for the Project with sub-contractors list,

(iv) Details of how the Contractor proposes to manage sub-contractors and to ensure that the relevant quality system requirements of ISO 9001/2 are observed and implemented by the sub-contractors in the execution of the works sub-contracted,

(v) The quality plans of the Contractor.

2 Manufacturer Qualifications

(a) A firm specializing in providing IP Surveillance Systems, similar to that indicated for this Project and with a record of successful in-service performance.

(b) Manufacturer's systems shall be, as often as possible, a standard "off-the-
shelf" package utilizing the latest hardware and software technology. Any major system development effort necessary to meet specified requirements is unacceptable. Even if this system is a new concept, it should not require huge development and shall be based on existing and proven technologies.

(c) Manufacturer or factory-authorized agency shall maintain a service center capable of providing training, parts, and emergency maintenance and repairs for overall system at Project site with eight hours of maximum response time.

3 Installer Qualifications

(a) An experienced Installer who is an authorized representative of the equipment Manufacturer for both installation and maintenance of Manufacturer's equipment, and who has completed system installations similar in design and extent to that indicated for this Project, with a record of successful in-service performance.

4 Materials and Workmanship

(a) They shall conform to the latest issue of all industry standards, publications, or regulations referenced in this Section, including the following, as applicable:

(i) Regulations and Standards: System components, parts, and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC).

(ii) Compliance with Local Requirements: Comply with applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Employer's Representative, in writing.

(iii) Conform to requirements of referenced industry standards, applicable Sections.

5 Source Limitations

(a) For each category of technology used for the IP Surveillance infrastructure, obtain system components from one Manufacturer who shall assume responsibility for the system components and for their compatibility.

40.1.8 Coordination

1 Coordinate Work of this Section with Employer’s existing:

(a) Routers/Switches/Workstations/Gateways.

(b) LAN passive network suppliers.

(c) Infrastructure and cabling contractors.

(d) Surveillance and security systems.

(e) Etc.

2 Coordinate with the Employer to confirm location of equipment, devices and
system components.

3 Meet jointly with representatives of concerned organizations, operators, contractors, and Employer's representative to exchange information and agree on details of project implementation, transition plan, equipment arrangements and installation interfaces, etc.

4 Record agreements reached in meetings and distribute record to other participants.

40.1.9 Testing And Reports

1 The Contractor shall test all components and circuits of the IP Surveillance System after installation to ensure functionality and performance within industry approved guidelines.

2 A written report shall be submitted describing testing procedure and detailing test results.

3 The Contractor shall provide and supply all necessary technical and skilled manpower, tools, test equipment, materials and transportation required for performing system and components testing.

40.1.10 Record Documentation

1 Operation and Maintenance Manuals

   (a) The Contractor shall submit full system documentation for the installed system and all ancillary equipment.

   (b) System documentation shall consist of:

   (i) A complete set of product data for all component and parts.

   (ii) A complete set of operations manuals for all components of the system.

   (iii) Maintenance manuals for all components of the system and for the system as a whole.

2 Test procedure, data and results from acceptance testing.

40.1.11 Warranty

1 Special Warranty

   (a) Manufacturer's Warranty: Provide written warranty, signed by the Manufacturer and the Installer agreeing to replace system devices and equipment that fail in materials or workmanship within specified warranty period.

2 Experimental Period

   (a) There shall be an experimental period of 90 days after successful testing and commissioning of the system, but before issuance of substantial completion certificate. During this period, the Contractor shall undertake supervision and responsibility for operation of the system under actual site
conditions. If any malfunctioning or anomaly noted on the system during this period, it shall be attended immediately. The experimental period will restart automatically from the date of clearing such troubles and start normal operation.

(b) During this period, the Contractor shall fully demonstrate the system performance under actual operation conditions. This demonstration is to confirm, to the satisfaction of the Employer’s Representative, that the system is free of remarks and is ready for provisional taking over.

(c) After the satisfactory completion of this period, the system is to be taken over by the Employer, as per Contract Conditions, whereby the Warranty Period is to commence.

3 Warranty Period

(a) Two years from the satisfactory completion of the Experimental Period.

(b) During the Warranty Period, the Contractor shall undertake Maintenance actions as defined in the Maintenance and Warranty Article.

(c) During the Warranty Period, the Contractor shall provide, at its own cost, all required spare parts needed to replace existing components unless it is proved that the component to be replaced was damaged by abuse.

40.1.12 Commissioning

1 Purpose

(a) In-System Commissioning

(i) The Contractor is responsible for the equipment installation in the system, so that the system stays globally functional. Therefore, equipment commissioning must be done through demonstration of product capability and compliance with requirements when wired and configured in the system.

(ii) Test system and power supply redundancies by unplugging redundant links.

(iii) Check recovery times.

(b) The Contractor shall be required to perform a range of Site Acceptance Tests on site for each individual sub-system to demonstrate that all items have been correctly installed and adjusted on a location by location basis and that the sub-system operates in every respect in accordance with the Specifications.

(c) During this phase the equipment are powered and the automation and networking are gradually integrated layer by layer.

(d) The tests shall be performed by the Contractor and witnessed by the Employer’s Representative.

(e) Any defects, which may become apparent during the course of these tests, shall be immediately rectified by the Contractor at his expense.

(f) The Site Acceptance Test Specifications shall be prepared by the Contractor and submitted for Approval.

(g) All Site Acceptance Tests shall be carried out in the presence of the
Employer's representative who shall sign off the testing documentation on satisfactory completion of the tests.

(h) The Site Acceptance Test Specifications, at every level, shall be subjected to configuration management and change control by the Contractor.

(i) If modification or reprogramming is required as a result of the tests, all affected parts of the Site Acceptance Tests, as determined by the Employer's Representative, shall be re-tested.

(j) The results of the Site Acceptance Tests, version of software and hardware tested, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer's Representative.

2 Tests

(a) Those tests are divided into 2 sub-phases.

(b) Preliminary Testing:

(i) Mechanical:
   1) Mechanical tests,
   2) Calibration of the components.

(ii) Automatism / Electrical:
   1) Powering Tests with electricity,
   2) Control of Input/Output,
   3) Control of the safety measure either personal or material,
   4) Test of local mode operation.

(iii) Network / Software Tests:
   1) Test of the Network,
   2) Test of the Supervision Workstation user interface,
   3) Test of the portable Terminal user interface.

(c) Test of the System:

   (i) The tests performed during this phase are performed with and without loading conditions.
   1) Testing the crippled mode (Safe shut down consecutive to loss of energy, etc.).

40.1.13 Maintenance

1 Support

(a) The Contractor must offer a comprehensive explanation of its Service Level Agreement (SLA) policy. The SLA should cover at least the following performance terms:

   (i) 99.999% availability. GTI and GTR should be guaranteed accordingly.

   (ii) Emergency level 24/24, 7/7 phone support shall be available. Distant
intervention on system must be offered.

(iii) High-level problem investigation support must be offered 5/7 during working hours.

(iv) Maintenance stocks must be properly sized by the Contractor in order to match operational quantities replacement needs given Manufacturers MTBFs for each equipment and components within the network.

(b) Maintenance service must include:

(i) Contract lifetime software patching for revealed problems during operations.

(ii) Contract lifetime hardware replacements on established malfunctions or weaknesses generating repetitive loss of service quality

(iii) Repairs in reasonable time for factory returned equipment.

2 Maintenance Service

(a) During the Warranty Period, Manufacturer or factory-authorized agency shall maintain a service center capable of providing spare parts and emergency maintenance and repairs for the overall system at Project site 7 days a week and 24 hours a day. Competent personnel shall be dispatched to rectify stoppages at any time during the day or night when being called on by the Employer.

(b) The Contractor shall submit a Service-Call Report to be sent to the Employer immediately following every call out, indicating the time of call out visit, cause, remedial action taken and the time that the service was restored.

(c) A Maintenance Manpower Plan shall demonstrate the Contractor’s committed resource level available for all types of activities to be carried out within the Warranty Period. Such plan shall be submitted for Approval six months before commencement of the Warranty Period.

(d) The Contractor’s response time, during the Warranty Period, shall not exceed 1 hour. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at where the faulty equipment is located.

(e) During the Warranty Period, the MTTR shall not exceed 30 minutes. The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing time on site, but shall exclude the response time.

(f) During the Warranty Period, the monthly average of the Repair Time shall be lower or equal to six minutes for each device. This performance will be checked.

(g) The Contractor shall liaise with the Employer’s Representative and carry out safety and performance inspections for the installation on site. Any necessary adjustments to the installation shall be made within 14 days of completion of such checks. A Safety and Quality Report shall be submitted, no later than 14 Days after such safety and performance checks, for the Employer’s Representative’s approval.

(h) The Contractor shall provide at least four inspection visits at six-month interval during the Warranty Period.
(i) The Contractor shall be responsible to clear away from the Site all surplus materials, rubbish, temporary works of every kind and leave the whole of the Site and installation clean and in a workmanlike condition to the satisfaction of the Employer’s Representative, upon completion of each item of the repair, and maintenance works.

3 Maintenance Performance Data

(a) Updates
   (i) The system will have to be conceived to facilitate the updates that will take place throughout its life. The replacement in exploitation of a version of software by the following one must be an easy operation, without risk, rapid and reversible.
   (ii) This update shall be transparent for the user and shall be done without interruption of the service.

(b) Corrections
   (i) In the event of error, the system shall have, as soon as possible, to store in a file a certain number of information allowing the correction of this error, e.g. entries in the transactions, faulty operations of the statistics, etc.

40.1.14 Global System Requirements

1 General
   (a) Coordinate the features of material and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

2 Expansion Capability
   (a) Unless otherwise indicated, provide equipment extensions capabilities for five years after each equipment delivery. The Contractor shall inform the Employer when extension limit is to be reached. Extension limit means:
      (i) Equipment in a given area unable to accommodate 20% further increase in network elements to connect. Limitation shall be made specific.
      (ii) System management tools are unable to accommodate 20% further increase in number of ports or network elements. Limitation shall be made specific.

40.1.15 Spare Parts And Extra Material

1 Contractor shall provide Manufacturer recommended spare parts for all major components in the system for two years fault free operation.

2 However, a minimum of 2% peripherals of each type installed, but not less than one from each type shall be included in the deliverable irrespective of Manufacturer recommendation.

3 During the Warranty Period, the Contractor shall provide, at his cost, all required spare parts needed to replace existing components unless it is proved that the
component to be replaced was damaged by abuse.

4 The Contractor shall guarantee the flow and availability of the spare parts without a major design change for at least ten years period.

40.2 PRODUCTS

40.2.1 System Requirements

1 General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

2 Servers, workstations, printers, and scanners shall be from one of the most reputed PC Manufacturers and the Manufacturer’s choice shall be coordinated under the full responsibility of Contractor.

3 All system equipment and specifications shall follow the requirements of MOI.

40.2.2 IP Cameras Requirements

1 A network camera is a device including the followings:

(a) Lens.
(b) Optical filter.
(c) Image sensor.
(d) Image digitizer.
(e) Image compressor.
(f) Zoom.
(g) Built-in software for web server with network connectivity.

2 Cameras types:

(a) Type 1: Indoor/Outdoor, fixed/Dome, anti-vandal color camera.
(b) Type 2: Indoor/Outdoor, high speed, anti-vandal color camera (PTZ).
(c) Type 3: Box Camera for number Plate recognition camera.

3 Cameras must be suitable for operation under extreme temperature, relative humidity and non-condensing.

4 High quality infrared camera must be used in full dark areas.

5 The IP camera shall be equipped with audio support functionalities.

6 The IP camera shall be equipped with motion detection functionality and alarms input/output with e-mail support.

7 Pan/Tilt/Zoom (PTZ) minimum requirements:

(a) Pan: +/- 160 degrees.
(b) Tilt: -90/+25 degrees.
(c) Zoom: 16x.
(d) Position Setting: minimum 8 positions.

8 Zoom:
(a) Manual.
(b) Fixed.
(c) Manual with support for external control.
(d) Optical and digital zoom.

9 Image Size:
(a) 1280 x 800
(b) 736 x 480.
(c) 640 x 480.
(d) 320 x 240.
(e) 160 x 120.

10 The minimum recommended camera resolution should be 1.3 MegaPixel.

11 The Contractor shall field-verify lens requirements for the defined design and angle of view for high quality, glare free, clear pictures at the video monitors.

12 Image Device: High resolution color CCD camera with an enhanced CCD sensor, solid state circuitry, and state of the art electronics incorporating the latest in digital technology. The color CCD sensor shall be:
(a) 1/6 inch 68K.
(b) 1/4 inch/ 38K.

13 Light sensitivity:
(a) 10 lux with f/1.4 lens.

14 Network Interface:
(a) 10/100baseT.

15 Software: The IP camera shall be equipped with built-in software for:
(a) Web server.
(b) FTP server.
(c) FTP client.
(d) E-mail client.

16 Supported Protocols, as a minimum: TCP/IP, FTP, SMTP, DHCP, SNMP, ICMP, and HTTP.

17 Image Buffer: 8MB.
18 Power: Built-in Power over Ethernet (IEEE 802.3af) support. Site cameras to be powered through power supplies.

19 Wireless: PCMCIA slot for wireless networking.

20 Other Features:
   (a) Modem Support.
   (b) Indoor/outdoor use.

21 The camera shall support both fixed IP addresses as well as addresses provided by a DHCP server.

22 Cameras used in the system for outdoor and indoor specific areas must have auto-iris, auto-ICR, auto-exposure, Backlight compensation, wide dynamic range, contrast enhancement, digital noise reduction, digital image stabilization, privacy masking, multiple gain control, white balance, intelligent video analytics, audio I/O, VPS/interlaced scanning features.

23 Camera Housings and Mounts: the housing is to provide long term protection of cameras, lenses, control electronics and accessories. It shall be designed to withstand direct solar heat and ambient condition (dust-tight and waterproof).
   (a) Wiring to all cameras shall pass from the back box through the mount and into the housing. Exposed wiring of any kind shall not be acceptable.
   (b) Provide sun shields for camera housings in outdoor locations exposed directly to sunlight.
   (c) Provide weather and dust proof camera housings with thermostatically controlled heaters and blowers in outdoor locations. Camera shall be rated IP66 for outdoor installation and IP65 for indoor installation.
   (d) Provide lightning protection for all exterior cameras.

40.2.3 Network Management System and System Software Requirements

1 The network management system shall be full-featured video matrix switching system allowing users to view and control each camera in the system from different nodes within the network.

2 The system shall include built-in video loss detection and system diagnostic features. Video loss detection alerts operators of a camera failure. Diagnostic monitoring assists in set-up, programming, and troubleshooting.

3 Matrix software shall allow for the activation of specific applications such as incremental switching mode (cyclic) and connection of alarms, event-actuated sub-routines, and for preventing or permitting various outputs.

4 The system shall be equipped with suitable and efficient backup mechanisms including backup management for archiving and restoring information.

5 The system shall provide a Graphical User Interface (GUI) that shall satisfy the following requirements:
   (a) A user-friendly operator interface for monitoring and controlling the system
through a Windows environment through the use of a computer mouse.

(b) Multiple, linked graphical maps including site and building floor plans. Icons placed on graphical backgrounds shall be used to select, control, and monitor each camera in the IP Surveillance System.

(c) Simple and logical navigation between graphical maps.

(d) A master graphic to direct operators to more detailed graphics. The GUI shall allow the operator to select the master graphic from any other graphic. Each map shall include camera and monitor icons located within the graphic area, and shall include icons to allow the operator to navigate between other areas near the current map.

(e) Import of graphics generated by other drawing programs. Include a conversion program with the system to convert DXF files from CAD programs into the format used by the system.

(f) Graphical map with high quality showing floor details including all partitions, doors and other major built-in structures.

(g) Overview of all incoming alarms, including filtering possibilities and control of multiple users handling the same alarm.

6 The system shall provide multi-level password protection and logging facilities that:

(a) Grant and/or deny rights to individual users or groups of users.

(b) Restrict the ability to modify the system configuration.

(c) Restrict access to video from specified cameras.

(d) Restrict access to alarm events.

(e) Restrict access to troubleshooting tools such as remote control functions.

7 The system shall allow playback and recording of cameras simultaneously.

8 The system shall allow simultaneous audio recording and playback.

9 The system shall allow playback with high speed date/time searching, skip searching, index searching, alarm list searching, and multi-screen option.

10 The system shall allow playback digital zooming (as an option); it shall allow the operator to zoom into a selected area of the image during playback and video authentication.

11 The software shall have the flexibility to be programmable for any recording or playback sequence.

12 The system shall provide remote P/T/Z camera control through web server.

13 The system shall be capable to notify users about its status and alarms by sending e-mails to a predefined address using SMTP.

14 The system shall allow for recording of up to 25 frames per seconds when connected to PAL cameras and 30 frames per seconds when connected to NTSC cameras.
15 The software shall provide the ability to limit storage of recorded video by automatically deleting recorded contents when the information reaches a pre-defined duration or date. The setting of these parameters shall be available on a per camera base, allowing for different settings for each camera.

16 To secure recorded video from being lost, the system shall allow an authorized user to manually “lock” recorded material from being erased or overwritten.

17 Recording shall be done using standard motion JPEG format without any modification of the pictures.

18 The system shall allow the export of video recordings in MPEG-4 or H.264 format and any other standard base format to the approval of the Employer’s Representatives.

19 The system shall provide the ability to export single video pictures to MPGE-4 or H.264 files as well as video sequences to AVI files.

20 The system shall allow search on time, date or activity/alarm with instant playback in real time with audio.

21 The system shall provide the ability to send operational and technical information using a standard SMTP mail server. To ensure availability, a minimum of two different mail servers must be definable.

22 To avoid improper use and configuring, the system shall provide the ability to define users and passwords for a minimum of three different types of users.

23 To ensure availability of video related to an alarm, the system shall provide a freely selectable pre and post-alarm recording. The duration of the pre-alarm time shall not be limited.

24 The system shall provide the ability to link events to selected time only, i.e. during out-of-office hours.

25 The system shall be able to select cameras to be recorded including date & time, title, update rate (real time and/or time lapse).

26 Protocols supported, as a minimum: TCP/IP, HTTP, SMTP, NTP, ARP, DHCP, and BOOTP.

### 40.2.4 Workstations, Servers & Data Storage Requirements

1 The PCs or system workstations are used for surveillance and alarm viewing as well as for data storage. The PCs shall be installed in a console in the CCTV control room. The design and finishing of the console shall be coordinated with the Architect, the operator and as per MOI regulations.

2 The PC or system workstation shall have the following minimum features and requirements (Management stations shall be industry standard PC’s each with a minimum specification or latest version at the time of purchase as follows):

   (a) Screen size: a single CCTV operator shall monitor no more than nine (9) camera displays at any one time in a standard SVGA 23” desktop screen
and 32" wall screen.
(b) Processor: 2.4 GHz P IV CPU.
(c) Hard disk 200 GB x6 = 1200GB = 1.2 TB.
(d) VGA Card 128 MB (with dual monitor as option).
(e) Network Card: 100/1000 Mbps.
(f) Full function control unit including full size keyboard, mouse and joystick.
(g) Operating systems: Windows, Unix, Linux.
(h) Operating temperature: +10° C to +55° C.
(i) Operating Voltage: 100/120/220V/240 V AC ±10%, 50 Hz.

3 The system shall support a wide range of automated storage options ranging from as little as a few hours of online storage capacity to keep long-term storage using hard drives, digital tape or other cost-effective long-term storage media. The system shall be capable of supporting unlimited video storage capacity by enabling system operators to periodically remove and replace hard drives, tape cartridge, or other removable storage media.

4 The system shall allow flexible storage architecture (centralized, local, and remote storage) for enabling best storage utilization.

5 The storage system shall be equipped with a database mirroring and distributed video storage features, which shall allow the system to sequentially distribute recorded video among the installed hard disks. And therefore, in case of a hard disk failure, the user shall be able to receive a relatively reduced frame rate, but shall not loose the complete video sequences.

6 Record and storage capacity shall ensure at least the recording for all the cameras for a period of 120 days, in MPGE-4 or H.264 format or other better quality compression techniques. Recordings must be set at 720p resolutions, 15fps and 100% continuous motion. The Contractor shall submit design calculations to justify the selection of the hard disk or other storage media and the capacity and type of the storage library.

7 Recorded and stored images shall be accessible from any workstation PCs connected directly to the LAN or via dial-up modem connections.

8 Scheduled Recording Administration:
(a) The system shall be able to establish a recording schedule based on hours of the day and days of the week.
(b) The system shall be able to specify the times during which each camera will be recorded along with the recording settings to be used during each period including the frame rate, resolution, and quality settings.

9 The storage system shall be designed to work with the Network Management System in order to send recorded pictures to all monitors or remote workstations on request.
40.2.5 LAN Infrastructure System Requirements

1. LAN equipment are not part of this Specification; however, in order for the IP Surveillance system to function properly the LAN infrastructure shall have as a minimum the features listed below.

2. Protocols: TCP/IP.

3. Traffic Management and Quality of Service Mechanisms.

4. VLAN/VLAN tagging (802.1q) support.

5. Hardware Redundancy.


7. Network Resiliency Features.

8. Power: Power over Ethernet support (IEEE 802.3af).

40.2.6 Alarms and Events

1. Overview: For the purpose of these Specifications, an “alarm” is any event that can be received or detected by an external equipment (access control for example) or internal (failure for example) and responded to in real time. Many types of events are not “alarms” in the traditional sense of an immediate problem such as a fire or intruder. An event can be any type of activity that may be the subject of future investigation and video review. The two basic requirements for an event are time and location:

(a) Time: A signal or data that can be detected or received in real time.

(b) Location: A physical location associated with the signal or data that can be related to cameras and camera presets.

2. All the pictures shall be recorded and stored, continuously or on event. The operation cameras output shall be recorded all the time. The security cameras output shall be recorded on event with pre and post alarm.

3. Alarm Recording: The system shall be equipped with Alarm Recording function that:

(a) Enables the system administrator to define alarm responses including instructions to trigger recording of specified cameras at specified frame rates and quality settings.

(b) Enables system administrator to determine the pre-alarm duration.

(c) Record cost-effective low frame rate video during non-alarm periods, and then start recording at high frame rate (real-time) in response to alarm events.

(d) Enables system administrator to determine whether video will be retained on long-term storage media for each continuous or scheduled recording instruction and automatically retain video on long-term storage media when video is recorded as part of a defined response to an alarm event.

4. Tasks Related to Alarms: The system shall be able to perform the following tasks:

(a) Execute video image analysis algorithms (video sensor), including activity
detection and video loss detection and generate alarm messages.

(b) Receive signals from alarm inputs and generate alarm messages.

(c) Send alarm messages to the server or program that manages alarm responses.

(d) Process alarm response instructions, change recording modes and control alarm relay outputs.

(e) Forward alarms from a remote node to a central alarm monitoring site, including modem or LAN/WAN communication.

(f) Motion detection feature shall be provided for fixed cameras looking at sensitive areas, in order to initiate alarm when unauthorized movement is detected. The Contractor shall coordinate and check precise location.

5 Event recording mode shall be used in relation with the Security System for access controlled doors.

6 The system shall perform the following tasks in response to requests from one or more workstations:

(a) Supply one or more live video streams.

(b) Enable one or more users to playback previously recorded video, including “instant replay” of video recorded within the last few seconds.

40.2.7 Interfaces

1 The IP Surveillance System shall be integrated and interfaced to the following systems:

(a) Security and Access Control System: The interface with the Security and Access Control System shall allow the control and the local surveillance of entrances, gates, each controlled crossing point as well as Emergency Exits, etc. Any breaking or violation of access provided with an IP camera will automatically pop up a window on the operator’s screen.

(b) Fire Alarm System: The interface with the Fire Alarm System shall allow the control and the local surveillance of each fire alarm zone. The system shall be able to display images as pop up window from the zone in alarm on the screen of the Fire Alarm System operator. The interface shall be compliant with NFPA requirements. The PTZ cameras shall automatically switch to the location of a fire alarm initiation. The fire alarm initiation shall be either the activation of any manual pull station, monitor module detection for flow switch activation, sensor, etc.

(c) Building Management System: The interface with the Building Management System shall provide the following information:

(i) Main System ON,

(ii) Main System OFF,

(iii) Main System in Default.

(d) Structured Cabling Network: The system shall be interfaced with the Structured Cabling Network to allow the communication between the Security and Access Control System, work stations, recording and storage servers, Network Management System, and all other interfaced systems
through the network backbone.

40.3 EXECUTION

40.3.1 Design

1 The design of the IP Surveillance System will consist of the following tasks:

(a) Needs Analysis - The Contractor shall work with the Employer’s Representative, departments, tenants and any other company or organization and determine their exact requirements.

(b) Engineering and Design - With the information gathered, the Contractor should determine hardware and software requirements for the Employer IP Surveillance System. This shall include the quantities and configuration of the system components and the configuration of the Network Management System.

(c) The Contractor shall determine the exact requirements for external communications and interfacing if it is determined that such services will be required for the support of the new system.

(d) The Contractor shall coordinate with the other disciplines to ensure that environmental requirements for the IP Surveillance System are met, and to ensure that cabling is installed at the locations specified during the needs analysis.

40.3.2 Project Management

1 The Contractor is required to supply a complete description (Project Plan) of the key activities required for the installation of the system.

2 In the project plan, the Contractor shall include a project organization chart with the reporting relationships of project team members and other key personnel. An escalation matrix should also be included.

3 It is essential that the installation of the new system be as transparent as possible to the users. There should be no service interruptions and no perceived degradation in the quality of service.

4 A master project schedule must be included, along with a work responsibility matrix, identifying the tasks the Contractor will perform and the tasks the Employer is expected to perform to successfully implement the new system.

40.3.3 Facility Requirements

1 The Contractor must furnish all space, power, and environmental requirements for the system.

(a) Space - Provide the physical dimensions of the equipment.

(b) Power - All power requirements, including any special conditioning or grounding requirements.

(c) Heat - The Contractor shall provide heat dissipation calculations for the room(s) housing the video surveillance equipment and the recommended safe temperature operating range for the system.
(d) Floor Loading - The Contractor must provide complete floor loading requirements.

40.3.4 Installation

1 General

(a) Acceptance of works will be restricted to the equipment and installations complying with the approved submittals, approved shop drawings, and the Employer site Engineer agreement.

(b) The Contractor has to carry out any site works under direct supervision of qualified technicians who are to be well trained with qualified Manufacturer experience.

(c) Site workmanship of any network component has to be limited to the layout and fixation, and inter-wiring of various items of the readymade equipment.

(d) In addition to the above, the Contractor is also expected to supply the following:

(i) Coordination meetings with the Project authorities, the Employer's departments, operators, existing contractors, etc.

(ii) Progress reports and Progress reviews,

(iii) Insurance for the Transport of the equipment,

(iv) Quality Assurance setup and management,

(v) Document Management,

(vi) Configuration Management for the duration of the Project,

(vii) Off-the-shelf Software updates for the duration of the warranty,

(viii) User documentation and training including textbooks,

(ix) Worksite expenses (Setup and removal of temporary offices, Worksite vehicles, Site Offices, Computers, Printers, Desks, etc.),

(x) Archival.

2 Site Survey

(a) Examine all the technical rooms and where equipment are to be deployed:

(i) Identify equipment location,

(ii) Identify links on patch panels,

(iii) Identify and check general power supply and grounding,

(iv) Procure premises environment characteristics (kW/m², air conditioning characteristics, etc.),

(v) Make heat dissipation calculation and adjust surface to be used according to rooms environment data,

(vi) Confirm feasibility for each technical room and location before starting to deploy.

(b) Proceed with installation only after unsatisfactory conditions have been corrected.
3 Examination

(a) Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

4 Equipment Data

(a) Submit complete technical data including Manufacturer's catalogues and specifications, system description including operational aspects, system features, and components.

5 Shop and Construction Drawings

(a) Submit drawings for approval.
(b) Constraints to be studied by the Contractor as part of its necessary Shop-Drawing development:

(i) The integration of the hardware (Equipment, Cables, etc.) shall be studied in such a way to deliver on site a package ready for installation.
(ii) The Contractor shall ensure the full coordination between the IP Surveillance System constraints and other systems or any other interfaced systems.
(iii) The Contractor remains responsible of the proper coordination as to avoid any technical mismatches.
(iv) All the system shall be studied, installed, and tested in order to offer an easy maintenance and access.
(v) All coordination due by the Contractor shall always cover both Hardware's and Software's. It also covers all aspects of Shop Drawing elaboration, manufacturing, construction, testing, and commissioning, to achieve comprehensive systems in proper and efficient working order.
(vi) The final coordination on site with Civil Works, Facades, Architecture, HVAC, Plumbing, Electrical and any other construction aspect, remains the duty of the Contractor.

6 Detailed System Schematic Diagrams

(a) Exact routing of cables, giving type and size,
(b) Exact location of cameras, equipment, components, cabinets, and racks as well as patch panels, etc. in Equipment room.

7 Typical Installation Details of the System Components

(a) After installation, the Employer shall be able to perform hardware configuration changes, to redefine any new mapping and modifications as desired without the services of the Installer or Manufacturer.
8 Coordination with Other Works

(a) It is under the Contractor responsibility to carry out any coordination between its own installations and other Project entities and systems.

(b) The layout shop drawings have to be used as a guideline and need to be improved before any site workmanship.

(c) The layout shop drawings are to also reveal the measures taken therein, and every fixation principle, and are to be approved by the Employer’s Representative.

(d) For this purpose any starting of work shall be subject to the Employer site Engineer approval.

9 Layout of Equipment

(a) Equipment is to be laid out properly in Equipment room and other locations in a way to reserve relevant space for maintenance activities. This space shall also include any future expansion of the system.

(b) Equipment is to be laid out as per the approved shop drawings.

(c) After the proper layout of all equipment is accomplished, all components are to be labeled, and marked according to an approved labeling designations and materials.

10 Installation Instructions

(a) Install equipment to comply with Manufacturer's written instructions.

(b) More precisely:
   (i) Use listed cable in environmental air spaces, including plenum ceilings.
   (ii) Install cable using techniques, practices, and methods that are consistent with a Structured Cabling Network (SCN) category rating of components and that ensure SCN category performance of completed and linked signal paths, end to end. Limit amount of cable untwisting to those defined by the Standard.
   (iii) Install cable without damaging conductors, shield, or jacket.
   (iv) Do not bend cable in handling or in installing to smaller radii than minimums recommended by the Manufacturer.
   (v) Secure and support cable at intervals not exceeding 750 mm and not more than 150 mm from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   (vi) Wiring within communication and security rooms: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by the Manufacturer.

(c) Cleaning: after completing system installation, inspect premises. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
11 Wiring Method
   (a) Install wiring in raceway.
   (b) Conceal cable and raceway.

12 Splices, Taps, and Terminations
   (a) Make splices, taps, and terminations on numbered terminal strips in
       junction, pull, and outlet boxes, terminal cabinets and equipment
       enclosures.

13 Impedance and Signal Levels
   (a) Match input and output impedance and signal levels at signal interfaces.
       Provide matching networks where required.

14 Identification
   (a) Identify system components complying with applicable requirements and
       the following Specifications.
   (b) Use a unique hierarchical alphanumeric designation in order to label:
       (i) IP Surveillance System equipment and components,
       (ii) Ports to terminals connected to the equipment.
   (c) Provide an identification database (which can be included with the
       management tool).
   (d) Color code conductors and apply wire and cable marking tape to designate
       wires and cables to identify media in coordination with system wiring
       diagrams.

15 Weatherproof Equipment
   (a) Install units that are mounted outdoors, in damp locations, or where
       exposed to weather consistent with weatherproof rating requirements as
       IP65 at least.

16 Cleaning
   (a) After completing system installation inspect exposed finish. Remove burrs,
       dirt, and construction debris and repair damaged finish, including chips,
       scratches, and abrasions.

17 Demonstration
   (a) Engage a factory-authorized service representative to train Employer’s
       maintenance personnel to adjust and maintain systems.
   (b) Train Employer’s maintenance personnel on procedures and schedules for
       starting and stopping, troubleshooting, servicing, and maintaining
       equipment and schedules.
   (c) Schedule training with Employer, through Employer’s Representative, with
       at least seven days advance notice.
18 Supervision

(a) Installation shall be supervised and tested by a representative of the Manufacturer of the system equipment.

(b) The work shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this work.

19 Security

(a) Coordinate with the Employer to procure general security conditions during building site.

(b) Check that drain conductors and equipment are grounded to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup and other impairments.

(c) Patch wiring must be traceable; Keep a database of patches installation up to date.

40.3.5 Wire And Cable

1 Principles

(a) All wiring and cable shall be installed in metal raceways or within equipment.

(b) Conductors within equipment enclosures shall be carefully cabled and laced.

(c) Individual conductors shall be tagged with markers indicating the function, source, and destination of all cabling, wiring and terminals.

(d) All cables and wires shall be identified, utilizing heat shrink, pre-printed, wire markers.

(e) Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.

(f) Separation of Wires: Comply with Standard rules for separating unshielded copper communication and data-processing equipment cables from potential EMI sources, including electrical power lines and equipment.

(g) Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.

(h) Use splice and tap connectors compatible with media types.

2 Number of Conductors

(a) As recommended by system Manufacturer for functions indicated.

3 Check-In and Tests

(a) After installation, and before termination, all wiring and cabling shall be checked and tested to ensure that there are no grounds, opens, or shorts on any conductors or shields.

(b) A V.O.M. shall be utilized to accomplish these tests and a reading of
greater than 20 Mega ohms shall be required to successfully complete the test.

4 Visual Inspection
   (a) Visually inspect wire and cable for faulty insulation prior to installation.
   (b) Protect cable ends at all times with acceptable end caps except during actual termination.

5 Protection
   (a) Protect wire and cable from kinks.
   (b) Provide grommets and strain relief material where necessary, to avoid abrasion of wire and excess tension on wire and cable.

6 Splices, Taps, and Terminations
   (a) Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

7 Identification
   (a) Identify components, conductors, and cables.
   (b) Color code conductors, and apply wire and cable marking tape to designate wires and cables so media are identified and in coordination with system wiring diagrams.

40.3.6 Raceways and Cable Trays

1 Raceways
   (a) Requirements:
      (i) Surface raceway shall be constructed and installed for all exposed communications outlets. The Contractor shall match as closely as possible the existing wall finish but shall not paint surface raceway. Surface raceway shall be:
          2) Constructed and installed per Article 352 of the NEC or any relevant local standard, mechanically and electrically continuous and shall be bonded in accordance with NEC and ANSI/TIA/EIA-607 codes and standards.
          3) Constructed and installed according to ANSI/TIA/568B and 569 standards and shall have a radius control at all bend points in accordance with the cable’s Manufacturer recommendation.
          4) Securely supported at intervals not exceeding 3 meters or in accordance with Manufacturer’s installation sheets.
      (b) Use communications cable tray wherever possible for low voltage cabling.
      (c) Exposed raceway below 2.4 meters and in dry locations shall be rigid steel conduit.

2 Cable Trays
(a) No IP Surveillance containment including cable trays, trunking, ducts etc. shall be loaded more than 60% of the available space. The Contractor is responsible to size the containment appropriately taking into account all systems and the type of cables to be used based on selected Manufacturer for each system.

(b) In general, IP Surveillance containment route shall follow the electrical containment route with sufficient clearance. However, any other routes followed shall be to the approval of the Employer’s Representative.

40.3.7 Field Quality Control

1 The Contractor shall submit to the Employer the manufacturing and shipment schedules for all equipment and/or materials at least one month prior to the time of packing for shipment as long as the lead time available is sufficient or such shorter period as may fit the actual circumstances. Should the Employer’s Representative fail to attend on the specified date for inspection, the Contractor shall proceed with shipment and carry out the relevant tests itself. The Contractor shall provide the Employer a copy of the recorded factory results made under its cognizance before shipment. If the test results show that the equipment and/or materials do not comply with the Specifications, such non-complying equipment and/or materials shall be rejected and shall not be shipped until repaired or replaced and tested again. In such case, the Contractor shall be held liable for any resulting delay. In all cases, the Contractor shall be responsible for the compliance of his equipment and materials with the Contract’s specifications.

2 Testing: On installation of system components, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

3 Correct malfunctioning units at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

40.3.8 Labeling And Administration

1 Labels

(a) They are required for equipment, cabinets, racks, bonding conductors, riser cables, access points, etc. Labels shall comply with EIA/TIA 606.

2 Rack Labeling

(a) Rack labeling shall be labeled sequentially and shall be of the form “01” to “0 xs”.

(b) Labels shall be of the minimum size of 100 x 50 mm, screwed yellow unit with 15 mm black letters/numbers.

40.3.9 Grounding

1 Precaution

(a) Properly ground each piece of electronic equipment prior to applying power.
(b) Properly ground all shielded wire shields to the appropriate clean earth ground at the equipment end only, not at the remote or device end.

2 Principles

(a) Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

3 Grounding Considerations

(a) General

(i) Grounding systems are normally an integral part of the specific signal and telecommunications wiring system that they protect. Besides helping protect personnel and equipment from hazardous voltages, the grounding system may reduce the effect of electromagnetic interference (EMI) on the structured cabling network. Improper grounding can produce induced voltages and those voltages can disrupt other data or telecommunications circuits.

(ii) When compatible with required electrical codes, the grounding instructions and requirements of the equipment Manufacturer should also be followed. The grounding requirements of the EIA/TIA 607 shall be followed.

(b) Considerations

(i) Ensure that the installation conforms to proper practices and requirements.

(ii) Ensure that each cabinet and rack has an appropriate grounding bus bar that is connected to the dedicated building ground by a 35 mm² ground wire.

(iii) Ensure that grounding is available for all system equipment and components and equipment required for maintenance and testing.

(iv) Ensure that all metal cable trays shall be bonded to ground. Cable tray shall not be used for a ground path.

40.3.10 Completion Services

1 The Contractor shall initiate system operation. The Contractor shall provide competent start-up personnel on each consecutive working day until the system is fully functional and ready to start the acceptance test phase.

2 Preparation for acceptance (prior to final inspection):

(a) Temporary and old systems, facilities and utilities shall be properly disconnected, removed and disposed of off-site, where applicable.

(b) All systems, equipment and devices shall be in full and proper adjustment and operation, and properly labeled and identified.

(c) All materials shall be neat, clean and unmarred and parts securely attached.

(d) Test reports of each system component shall be complete and available for inspection and delivery as directed by the Employer’s Representative.
3 System acceptance requirements: Before final acceptance of work, the Contractor shall deliver six (6) composite "Systems Operation and Maintenance" manuals in three-ring binders, sized to hold the material below, plus 50% excess. Each manual shall contain, but not be limited to:

(a) A Statement of Guarantee including date of termination and the name and phone number of the person to be called in the event of equipment failure.

(b) A set of operational procedures for the overall system that includes all required activities and that allows for Employer's operation of all system capabilities. This procedure shall fully address Employer's established system operating objectives.

(c) Individual factory-issued manuals, containing all technical information on each piece of equipment installed. In the event such manuals cannot be obtained from a manufacturer, it shall be the responsibility of the Contractor to compile and include them. Advertising brochures shall not be used in lieu of the required technical manuals and information. All manuals shall be printed to ensure their permanence. No “blue-line” type of reproduction is acceptable.

40.3.11 Factory Tests

1 Factory Acceptance Tests

(a) The Factory Acceptance Tests shall be carried out in a hardware and software environment, which simulates the final configuration of the system.

(b) The Contractor shall carry out any Factory Acceptance Tests, in Manufacturer's factory itself, before any site delivery, in order to show to the Employer site Engineer that the system of both hardware and software and the system after integration of various sub-systems is able to satisfy site technical requirements of the equipment specifications.

(c) Some of the functional or performance tests, which cannot be conducted in a simulated environment, due to their nature and complications, may subject to the Employer's Representative's approval be combined with the On Site Tests.

(d) All travels and trips costs shall be provided by the Contractor for five (5) representatives to be nominated by the Employer.

2 Test Specifications

(a) Following the methodology presented in the Test Plan, all tests are to be carried on according to Test Specifications, which are submitted by the Contractor and approved by the Employer's Representative.

(b) The tests are to cover every aspect related to the specification of the system and its operation; including, but not limited to, visual inspections, measurements, and operation.

(c) All Factory Acceptance Tests need to be carried out in the presence of the Employer's Representative unless otherwise agreed by the Employer's Representative. The Employer's Representative will sign off the testing document on satisfactory completion of the tests.

(d) All Factory Acceptance Test Specifications, at every level, shall be subject
to configuration management and change control by the Contractor.

(e) The results of the Factory Acceptance Tests, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer’s Representative.

3 Equipment Tests

(a) Equipment is to be tested for quality and operation at the factory, and test certificates and reports, certified by an official testing authority, are to be submitted to the Employer’s Representative before dispatch of equipment to site.

40.3.12 On Site Tests And Inspection

1 On Site Assembly Verification

(a) The purpose of this phase is to check the assembly and the connection of the equipment without any power supply.

(b) Any verification can give raise to a punch list item either because of an anomaly or a none-conformity with the tender documents.

(c) The punch lists are collated for each module and the phase report is only released when all the stipulations on the punch lists are cleared.

2 Test Specifications

(a) Following the methodology presented in the Test Plan, all tests are to be carried on according to Test Specifications, which are submitted by the Contractor and approved by the Employer’s Representative.

(b) The tests are to cover every aspect related to the specification of the system and its operation including, but not limited to, visual inspections, measurements, and operation.

3 On Site Cable Tests

(a) Cables are to be tested to ensure that no damage have occurred to them during transportation to site and/or during the course of pulling in and laying.

4 Inspection

(a) Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

5 Pre-Testing

(a) Align and adjust system and perform pre-testing of all components, wiring, and functions to verify compliance with specified requirements.

(b) Correct all deficiencies by replacing malfunctioning or damaged items with new items.

6 Manufacturer’s Field Services
(a) Engage a factory authorized service representative to inspect field assembled components and equipment installations and perform system pre-testing, testing, adjustment and programming.

(b) Report results in writing.

7 Procedure

(a) Notify the Employer’s Representative not less than 30 days in advance, of proposed schedule, procedures and tests to be used in operational testing.

(b) Conduct operational tests only with the Employer’s Representative present.

8 Report

(a) Prepare a written report of observations, inspections, tests, and results, including:

(i) A complete listing of every device and circuit,

(ii) Date of each test and retest, and by whom,

(iii) Results of each test and, if failure occurred, corrective action taken prior to retest.

9 Certification

(a) The Contract shall certify that all devices, circuits, and total system are finally tested successfully.

10 Operational Tests

(a) Schedule tests after pre-testing has been successfully completed.

(b) Perform operational system tests to verify compliance with Specifications.

(c) Test all modes of system operation including:

(i) Functional operation of each field mounted device,

(ii) Functional operation of each control circuit,

(iii) Supervision function of each initiating, indicating, monitoring, and control circuit,

(iv) Perform tests that include originating program and counting material at final outlets, controller inputs, and other inputs,

(v) Signal Ground Test: Measure and report ground resistance at each global equipment pin.

(vi) Re-testing: Correct deficiencies, and re-test. Prepare written record tests.

(vii) Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

(d) Schedule tests with at least seven days advance notice of test performance.

11 Integrated Tests with Other Contractors
(a) The Contractor shall make equipment available for testing and demonstrating various features specified.

(b) The test procedures shall reflect the sequence of tests to be performed.

(c) Typical test segments shall include but shall not be limited to the following:

   (i) Communication Tests shall be performed for the serial or LAN interface to ensure that proper communication can be established between the IP Surveillance System equipment and the interfacing systems.

   (ii) Point-to-Point Tests shall be performed on the IP Surveillance System equipment to the interfacing systems in order to verify the functionality and correct animation of each I/O point/command including alarm messages.

(d) Retesting: Correct deficiencies and retest until total system meets requirements of the Specifications and complies with applicable standards. Prepare written records of tests.

(e) Schedule testing with at least seven days advance notice.

40.3.13 Training

1 The Contractor is required to conduct end-user training on the Employer's premises, tailored specifically to the Employer's particular requirements in the use, configuration and maintenance of the IP Surveillance System equipment and components.

2 Training shall be provided for Technical Staff of the Employer in the Testing, Maintenance and Fault Location of the IP Surveillance System.

3 For each product and/or application, the Contractor shall provide a detailed description of the training the Manufacturer will provide.

4 Trainers

   (a) All training shall be certified training by Manufacturer and trainers shall be approved by the Employer before starting.

   (b) Engage a factory authorized service representative to explain programming and operation of system and to train Employer's personnel on procedures and schedules for maintaining, programming, operating, adjusting, troubleshooting, and servicing the system.

5 Training Program

   (a) Scope

      (i) Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and/or maintain the equipment, systems, and facilities provided and installed under this Contract, and to ensure a smooth transition between construction and operations activities.

   (b) Language

      (i) Training shall be conducted in English and Arabic.
(c) Training Aids

(i) Training aids shall include:

1) Approved Operation and Maintenance (O & M) manual(s) prepared by the Contractor as part of this Contract,
2) Training manuals, including course outline, basic text of instructions modules, and trainee workbook,
3) Films, slides, video tape(s),
4) Charts, models, hand-outs, catalogues,
5) Samples and other visual,
6) Written aids to complement instruction.

(ii) In addition, spare parts and other special hardware shall be provided to support “hands-on” familiarization with the equipment or systems.

(d) Training Manuals

(i) Training manuals shall be provided for each training course covering both the classroom and on-the-job phases.

(ii) The organization of the manuals shall follow the same sequence as the course’s scheduled presentation of material, providing such additional background and supplementary information, as a trainee may need to understand the O & M manuals.

(iii) There shall be as many Training Manual types as Trainees categories.

(e) Training Execution

(i) Scope

1) Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training.

(ii) Contents

1) Training course can be broken down into modules either classroom lecture or ‘On-the-job’ training.
2) In case of lecture, it is the Employer responsibility to provide the classroom for the duration of the course.
3) No lecture module should exceed 2 hours time.
4) “On-the-job” training can be scheduled for entire 8 hour shift.
5) Handouts must support each module; the collation of the Handouts forms the Training Manual.
6) Laboratory equipment, spare parts, and mock-up models may be used for theoretical orientation.
7) However, practical “hands-on” familiarization shall be provided on equipment that is either installed and operable or ready to be installed and capable of being operated. System spares of special hardware items may be used to support “hands-on” familiarization as long as said spares are returned to inventory in satisfactory condition in accordance with approved
procedures.

(iii) Proficiency
1) At designated intervals each trainee’s proficiency levels shall be determined by written, oral and practical performance tests.

(iv) Operations Training
1) Operators shall be provided with a thorough training in all aspects of system/sub-system operation under both normal and abnormal conditions. This training shall include, but not be limited to:
   a) Orientation to provide overview of system/sub-system purpose, configuration, and operations,
   b) Terminology,
   c) Operations theory and interface,
   d) Equipment appearance, functions, concepts and operations,
   e) Operating mode, practices, and procedures under normal and emergency conditions,
   f) Safety precautions,
   g) On-the-job operating experience covering all system/sub-system operating functions, activities, and tasks including those associated with degraded operating modes, failure recognition, and recovery processes,
   h) Familiarity with content and use of O & M manuals and related reference publications.

(v) Maintenance Training
1) Maintenance training shall cover all on-site routine, preventive, and remedial maintenance of the system/sub-system.
2) This training shall include, but not be limited to:
   a) Orientation to provide overview of system/sub-system purpose, configuration, and operations,
   b) Terminology,
   c) Operations theory and interfaces,
   d) Equipment appearance, layout, functions, concepts and operations,
   e) Operating modes, practice, and procedures under normal and emergency conditions,
   f) Safety precautions,
   g) Use of tools and test equipment,
   h) Use of system utilities, diagnostic software and various software tools associated with the system maintenance,
   i) Preventive maintenance,
   j) Troubleshooting, diagnostics, and testing,
   k) Backup and restoration of software/configuration,
l) Assembly and disassembly,
m) Repair and parts replacement,
n) Parts ordering practices and storage,
o) Failure and recovery procedures,
p) System/sub-system cabling,
q) Familiarization with and use of O & M manuals and other reference materials.

(vi) Administrator Training

1) Administrator course shall be provided so the system administration staff will be able to:
   a) Configure the IP Surveillance System equipment and the access of all the users,
   b) Identify and remedy software faults,
   c) Upgrade and implement data and software changes,
   d) Production of revised or new displays.

2) This training shall include, but not be limited to:
   a) Orientation to provide overview of system/sub-system purpose, configuration, and operations,
   b) Terminology,
   c) Operations theory and interfaces,
   d) Software design and organization,
   e) Database structure, generation, and modification,
   f) Assembly, compilation, linking, editing, debugging, distributing, testing and integration of program modules,
   g) Interface software design,
   h) Configuration management and control of software,
   i) Backup and restoration of software,
   j) Use of system utilities, diagnostic software and various software tools associated with the design, development, and maintenance of the System,
   k) Familiarization with and use of O & M manuals and other reference materials.

40.3.14 Maintenance And Warranty

1 The IP Surveillance System and all associated equipment in the Contractor’s solution shall be warranted by the Contractor and by the Manufacturer to be free of defects in equipment, software, and workmanship for a period of at least two years from the date of Substantial Completion.

2 During the warranty period and any subsequent maintenance agreement, any defective components shall be repaired or replaced at no cost to the Employer.
3 All system maintenance during the warranty period and under any subsequent maintenance agreements shall be performed by the Contractor organization using personnel employed full time by the Contractor and at no additional cost to the Employer other than those charges stipulated to maintain the warranty.

40.3.15 Logistical Support

1 The Contractor should identify the address of the Manufacturer's local service centers and the number of service personnel trained on the system.

40.3.16 Repair Response

1 The Contractor shall provide routine system monitoring to assure the continued operation of all system components.

2 During the warranty period, the Contractor must supply no more than a 1 hour response to major problems, 24 hours a day, 7 days a week.

40.3.17 Guidelines For Documentation Transmittal

1 Content of the Transmittals

(a) Contractor to prepare detail drawings, design calculations, technical data sheets and samples and submit the same for review by the Employer's Representative. The Contractor shall submit the following key elements to the Employer's Representative for review:
   (i) Detailed layout showing the marking and/or the equipment as required,
   (ii) Manufacturers' Catalogues,
   (iii) Provide all relevant Testing Certificates,
   (iv) Inventory label for each item supplied under this Contract. Labels shall be submitted for review by the Employer's Representative and shall be attached to each individual item for easy reference.

(b) The following documents are to be submitted to the owner prior to handing over:
   (i) As-built drawings for the relevant areas,
   (ii) Complete inventory list,
   (iii) Three sets of the Maintenance Manuals are to be provided. Such manuals shall include a full technical description with block and schematic diagrams to allow the Employer staff to maintain the system equipment and components,
   (iv) Three sets of the Operation Manuals are to be provided.

2 Drawings

(a) The Contractor will have to establish plans to scale and diagrams as per the following presentation:
   (i) IP Surveillance System schematic diagrams, detailed design, connection diagrams, etc.
(ii) Floor layout of each building and raceways will have to be on scale 1/100.

(iii) Equipment room layout will have to be on scale 1/50.

(iv) Racks and cabinet configuration, front and back view, as well as the plans of detail and service shafts, will have to be on scale 1/10.

(b) All Design Development drawings, Construction Drawings, and As-Built Drawings shall be submitted in hard copy format as well as in electronic format in the quantities specified below.

(c) Quantity of Submittals:

(i) Electronic Files: 1 set.

(ii) Reproducible hardcopies: 1 set.

(iii) Prints: 3 sets.
Add the following completely new Part titled: Part 41 – Access Control System.

41. ACCESS CONTROL SYSTEM

41.1 GENERAL

41.1.1 Related Documents

1 Contract

   (a) Drawings and general provisions of the Contract, including Conditions of Contract and Specification Sections, apply to this Section.

   (b) In particular, refer to these documents for all elements related to costs and responsibility related to delivery, storage, and roll-out phase.

41.1.2 Definitions

1 BMS: Building Management System.

2 DC: Door Controller.

3 CCTV: Closed Circuit Television.

4 FAS: Fire Alarm System.

5 GUI: Graphical User Interface.

6 HTTP: Hyper Text Transfer Protocol.

7 HMI: Human Machine Interface.

8 MTTR: Mean Time To Repair

9 MTBF: Mean Time Between Failures.

10 PKI: Public Key Infrastructure.

11 SACS: Security and Access Control System.

12 SCN: Structured Cabling Network.

13 UPS: Uninterrupted Power System.

14 XML: Extensible Mark-up Language.

** Employer throughout the specifications refers to Public Works Authority (PWA).

** Operator throughout the specifications refers to Primary Health Care Corporation (PHCC).
41.1.3 System Description

1 Introduction

(a) The present document is to describe the Security and Access Control System to be installed for the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor.

2 Interfaced Systems with Security and Access Control System

(a) The interfaced systems with the SACS are:
   (i) The Building Management System (BMS),
   (ii) The Fire and Alarm System (FAS),
   (iii) The Closed Circuit TV (CCTV),
   (iv) The Structured Cabling Network (SCN),
   (v) The Uninterrupted Power Supply (UPS),
   (vi) The Architectural Design,
   (vii) Others as deemed necessary.

(b) The above systems shall be interfaced with the SACS to allow full duplex communications between itself and all above interfaced systems throughout the backbone.

3 Design Requirements

(a) Scope of Work:
   (i) The Scope of Work shall include, but not limited to, detailed engineering, fabrication and coordination thereof, supply and installation of all specified equipment, operator training, hardware, software, wiring, cabling, labor, supervision, management control, testing, commissioning, systems interfaces, maintenance and 24 month warranty for all supplied equipment.
   (ii) In addition to the above, the Contractor is also expected to supply the following:
      1) Coordination meeting with the Employer, authorities, contractors, etc.,
      2) Progress reports and Progress reviews,
      3) Insurance for the transport of the equipment,
      4) Quality assurance setup and management,
      5) Document Management,
      6) Configuration management for the duration of the project,
      7) Off-the-shelf software updates for the duration of the warranty,
      8) User documentation and training including textbooks,
      9) Worksite expenses (set up and removal of temporary offices, worksites, vehicles, site offices computers, printers, desks, etc.).
10) Archival

(iii) It is asked to provide a complete Security and Access Control System for the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor. The main objective remains to secure the opening of doors and to secure the access to different areas. Depending on the border of these different areas a certain type of equipment will be required.

(iv) The system includes, but not limited to, the following:

1) Proximity Card Readers (CR) for specific locations as shown on Drawings.

2) Card Readers Door Controllers (DC) for control of a specific number of readers.

3) Monitoring, Management and Control System for the Security and Access Control System implemented for the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor installed in the Equipment Room at the ancillary building with a remote monitoring terminals at other remote locations connected to the LAN.

(v) The system shall be a modular and connectable to a Structured Cabling Network (TCP/IP). The system shall be capable of access control of selected doors, alarm monitoring, video imaging and badging, and CCTV camera call-up that allows for easy expansion or modification of inputs, outputs, and remote control stations and able to integrate different technology of Biometrics Readers in the future, if required by the Employer. The system control at the host workstation location (Building Management room) shall be under a single software program control and shall provide full integration of all components, existing (if applicable) and new, and shall be alterable at any time, depending upon the facility requirements. Reconfiguration shall be accomplished online through system programming, without hardware changes.

(vi) A cardholder that uses his/her card and do not open the controlled door shall not be considered as entered in the corresponding zone.

(vii) Each alarm shall be capable of initiating a number of different actions, such as camera switching, activation of remote devices, door control, and card readings.

(viii) Equipment repair shall be possible on site by module replacement.

(ix) All control components shall utilize “Distributed-Processing” concepts. The distributed processing shall include the ability to download operating configured to any Controller Unit, thus allowing the panel to provide full operating functions independent of any other system components.

41.1.4 Submittals

1 Product Data

(a) Product Data: For each type of product indicated. Include operating characteristics, furnished specialties, and accessories. Reference each product to a location on Drawings.
(b) Product data submittal shall include the following, as a minimum:
   (i) Schedule of equipment proposed, with catalogue reference number.
   (ii) Name and address of the Manufacturer and country of origin of the product.
   (iii) Compliance statement to specification, with necessary supporting documents.
   (iv) Catalogue pages of proposed equipment.
   (v) Basic system architecture indicating tie-in points with existing services.
   (vi) Name and address of the authorized local representative/dealer.
   (vii) System functional description and application.

(c) Include data on features, ratings, and performances.

2 Shop Drawings
   (a) Locate devices as shown on Drawings.
   (b) Layout drawings showing location of devices, doors, controllers, cables and containment, etc.
   (c) Diagrams for cable management system.
   (d) System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system.
   (e) Wiring Diagrams: they shall show typical wiring schematics, including typical installation details, doors hardwiring scheme, dimensions, etc.
   (f) Detail system schematic for each area.

3 Manufacturer's Installation Instructions
   (a) Provide Manufacturer’s installation instructions.

4 Integration Control Document
   (a) The Contractor shall supply with his submission the Integration Control Document (ICD) on which the standard protocol shall be mentioned.

5 System Operation Description
   (a) Include method of operation and supervision of each component and each type of circuit, and sequence of operations for manually and automatically initiated system inputs.
   (b) Description must cover this specific Project; Manufacturer’s standard descriptions for generic systems are not acceptable.

6 Product Certificates
   (a) The Contractor shall provide certificates signed by Manufacturers of components certifying that products furnished comply with requirements.
7 Qualification Data
(a) For firms and persons specified in "Quality Assurance" an article shall be written to explain and demonstrate their capabilities and experience.
(b) To include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by the Engineer.
(c) System Operation Description: Include method of operation and supervision of each component and each type of circuit, and sequence of operations for manually and automatically initiated system inputs. Description must cover this specific Project; Manufacturer's standard descriptions for generic systems are not acceptable.

8 Tests and Certificates
(a) Submit complete certified Manufacturer's type and routine test records, in accordance with the Standards specified in "Quality Assurance" Article.

9 Field Test Reports
(a) As specified in "Field Quality Control" Article of this Section, the Contractor shall indicate and interpret test results for compliance with system description and performance requirements.

10 Record (As-Built) Drawings shall include:
(a) Complete wiring diagrams, including complete terminal strip layout and identification, and wire termination and tagging for all conductors.
(b) Locations for all components installed and/or connected to under this Specification.

11 Sample Warranty
(a) Copy of Manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.
(b) Provide copy of sub-contractor's warranty certificates.
(c) Provide Contractor warranty certificates.

12 Maintenance Data
(a) For Security and Access Control System, documents shall include Emergency, Operation, and Maintenance manuals. In addition to items specified above, manuals should include, but not only, the following:
   (i) System software documentation.
   (ii) Server installation and operating documentation, including all installed peripherals.
   (iii) Hard copies of Manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hardcopy submittal.
   (iv) System installation and setup guides, with data forms to plan and
record options and setup decisions.

(v) As-Built layouts and schematics.

(vi) System operation.

(vii) Maintenance schedule.

(viii) Power supply schedule.

(ix) Integration and interfaces with other systems documentations.

13 Format and Presentation of the Documents

(a) The Contractor shall establish plans to scale and diagrams as per the following presentation:

(i) Floor layout of the building and raceway will have to be on scale 1/100.

(ii) Equipment room layout will have to be on scale 1/50.

(iii) Racks and cabinet configuration, front and back view, as well as the plans of detail and service shafts, will have to be on scale 1/10.

(b) The Contractor shall give the whole set of documents in three copies on electronic (CD Rom) and paper.

(c) The documents shall be submitted in the following standard formats:

(i) Dxf format of AutoCAD (TM), most recent version, for the plans, diagrams and synoptic.

(ii) Xls format of Excel (TM), most recent version, for the tables and schedules.

(iii) Word format (TM), most recent version, for the text documents, handbooks, etc.

(iv) Pdf format of Adobe Acrobat (TM), most recent version, for the technical data sheets and Manufactures catalogues.

41.1.5 Regulation And Standard

1 Rules

(a) The supply shall be conformed to requirements of referenced industry standards, applicable sections.

(b) The supply shall be compliant with Local Requirements, applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Engineer, in writing.

2 Standards

(a) System components, parts and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC)

(i) ISO/IEC 11801: latest edition regarding Information Technology and Generic Cabling for DCstomer Premise.
(ii) ISO 14443 A or B Standard.

(iii) EIA/TIA 568, Commercial Building for Telecommunication Wiring Standard.

(iv) EIA/TIA 569, Commercial Building for Telecommunication Pathways and Spaces.

(v) EIA/TIA 606 for Telecommunications Infrastructure: This document provides the user of this document with guidelines and choices of classes of administration for maintaining telecommunications infrastructure.


(vii) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.

(viii) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.

(ix) IEC 60331 Part 11& 12, Tests for Electric Cables under Fire Conditions.

(x) IEC 60332 Tests on Electric Cables under Fire Conditions.

(xi) IEC 60364-1 Electrical Installations of Buildings, Fundamental Principles, Assessment of General Characteristics, Definitions.

(b) Several material and test standards have been developed and published by Institute of Electrical and Electronics Engineers (IEEE) for data communications industry, focusing on local area networks (LAN):

(i) 802.1 - Network Management Group.

(ii) 802.2 - Logical Link Control Group.

(iii) 802.3 - Carrier Sense Multiple Access/Collision Detection Group.

(iv) 802.6 - Metropolitan Area Networking Group.

(v) 802.7 - Broadband Technical Advisory Group.

(vi) 802.8 - Optic Fiber Technical Advisory Group.

(vi) 802.9 - Integrated Voice and Data LAN Working Group.

(viii) 802.10 - LAN Security Working Group.

(ix) 802.11 - Wireless Networks.

(x) 802.12 - Fast Ethernet.

(c) ISO: International Standardization Organization:

(i) It promotes the development of international standardization with scientific, technological and economic activities.

(ii) The Technical Committee 97, Information Processing, developed a seven-layer communications reference model that allows multiple protocol and multiple vendor environments to interconnect and operate with one another.

(d) Comply, as often as possible, with both ITU-T (International Telecommunications Union) recommendations and US standards. When
standards are not compatible in both Europe and US (e.g. telecom interfaces SDH STMx vs. SONET OCx) detailed compatibility and interface availability shall be provided.

(e) National Electrical Code (NEC):
   (i) Many local building codes are based on the NEC and are a must for those responsible for providing a safe implementation of a communication system. Articles 700-800 of the NEC handbook address communications cabling issues.

(f) Building Industry Consulting Service International (BICSI):
   (i) Publishes the Telecommunications Distribution Methods Manuel (TDM), which is a comprehensive collection of accepted practices in the design and methodology of communications systems. BICSI provides a competency examination for the professional designation as a registered Communications Distribution Designer.
   (ii) This manual should be used as a reference only.

(g) Network Equipment Building System (NEBS):
   (i) Level 1, Level 2, and Level 3 are applicable to these section.

3 Precautions:
(a) The above list is a partial list issued from standard organization. Additional consideration may be required to provide protection of communications equipments, data processing equipment and protection of data from intrusion, induced noise or other events that can disrupt vital operation.

41.1.6 Performance Requirements

1 Security and Access Control System Performance
(a) Distributed Processing: The system shall be a fully distributed processing system, so that information, including time, date, valid codes, access levels, and similar data, is downloaded to Controllers so that each Controller makes access control decisions for that location. Do not use intermediate Controllers for access control. If communications to server are lost, all Controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the server.

(b) Server shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Server shall control system networks to interconnect all system components, including workstations and field-installed Controllers.

(c) Field equipment shall include Controllers, sensors, and controls. Controllers shall serve as an interface between the Server and sensors and controls. Data exchange between the Server and the Controllers shall include down-line transmission of commands, software, and databases to Controllers. The up-line data exchange from the Controller to the Server shall include status data such as intrusion alarms, status reports, and entry-control records. Controllers are classified as alarm-annunciation or entry-control type.
(d) System Response to Alarms:
   (i) Field device network shall provide a system end-to-end response time of 1 second(s) or less for every device connected to the system.
   (ii) Alarms shall be annunciated at the Server within 1 second of the alarm occurring at a Controller or device controlled by a local Controller, and within 100 ms if the alarm occurs at the Server.
   (iii) Alarm and status changes shall be displayed within 100 ms after receipt of data by the Server.
   (iv) All graphics shall be displayed, including graphics-generated map displays, on the console monitor within 3 seconds of alarm receipt at the security console. This response time shall be maintained during system heavy load.

(e) Error Detection:
   (i) A cyclic code error detection method shall be used between the Controllers and the Server, which shall detect single- and double-bit errors, burst errors of eight bits or less, and at least 99 percent of all other multi-bit and burst error conditions.
   (ii) Interactive or product error detection codes alone will not be acceptable.
   (iii) A message shall be in error if one bit is received incorrectly.
   (iv) System shall re-transmit messages with detected errors. A two-digit decimal number shall be operator assignable to each communication link representing the number of re-transmission attempts.
   (v) When the number of consecutive re-transmission attempts equals the assigned quantity, the Server shall print a communication failure alarm message. System shall monitor the frequency of data transmission failure for display and logging.

(f) Data Line Supervision:
   (i) System shall initiate an alarm in response to opening, shorting, or grounding of data transmission lines.

(g) Expansion Capability:
   (i) The system shall have provision to increase the number of security access points in the future by 100 percent above those indicated without adding any internal or external components or main cable conductors and respective raceways.

(h) The Contractor shall guarantee that operation and maintenance by the Employer’s personnel with proper training shall enable the SACS to fulfill the following performance requirements:
   (i) Availability: 99.8 % over 30 floating days for the SACS Server.
   (ii) Card Reader (CR): one CR out of service shall not occur more than 5% of the time.
   (iii) MTTR: 30 minutes maximum.
   (iv) MTBF of CR and Door Controller (DC): 50,000 hours minimum.
(i) In order to acquire the necessary performance data, the BMS system server shall poll the SACS Server; Status of all CR and DC equipment shall be forwarded to allow performance level computation.

(j) For servers and workstations, the Contractor's choice shall be submitted to the Engineer for approval, to ensure proper reliability.

(k) In order to achieve the requested MTTR and MTBF, modular conception and quick interchange of modules is required for SACS components such as CR and DC.

(l) DC: in local mode, the maximum time between a device activation and the real unlock of the access shall be less than 1.5 seconds.

(m) Main SACS Server:
  (i) The maximum time between a door alarm appearance or an information elaboration by a DC and the display on the MHI shall be less than 3 seconds.
  (ii) The maximum time between a screen display request by a switch push, with the mouse, or an alarm appearance and the total display on the screen shall be less than 2 seconds.
  (iii) The complete loading of the white list (case of a maximum configuration with 1,000 DC) in all the DC connected to the Server shall be ended in less than 10 minutes.
  (iv) A configuration element (creation/modification/deletion of right for a badge, exploitation planning, etc.) shall be taken into consideration by all the DC in less than: 1 minute.
  (v) A server dysfunction must not modify the good work of the other elements of the system. For the restoring of the main SACS Server, all the procedures and the updating of the data must be totally automatic (no manual intervention).
  (vi) All the information not sent during the dysfunction shall be send during the restoring.
  (vii) The application initialization (cold start) shall be ended in less than 30 minutes.

2 Dimensions Requirements

(a) Main SACS Server Requirements:
  (i) More than 1,000 DC could be connected without performance loss (response time).
  (ii) The historical database shall be able to memorize all the events during 24 months (on a base of 1,000 events/day and by access).
  (iii) The display of a historical state shall take less than 5 seconds (searching with 3 keys of selection).

(b) Operators' Workstations:
  (i) The SACS system shall be able to have unlimited operators' workstations with all features of the main supervision workstation.

3 Working Safety
(a) CU:
   (i) The equipment availability must be of 98%.
   (ii) DC shall be able to manage the loading by the remote server or, locally, in independent mode, without information loss.
   (iii) A dead server or any problem or change of configuration shall not disturb the DC operation in the system.
   (iv) In case of electrical loss, configuration and memorized data have to be saved. When the power comes back, the DC must be able to operate immediately without any human intervention.

(b) Events Avalanche Management:
   (i) Events avalanche must not disturb the system operation.
   (ii) Events avalanche shall be managed by the DC and the main SACS Server.
   (iii) Events avalanche must not be responsible of any information loss.

41.1.7 Quality Assurance

1 Requirements
   (a) The Contractor shall implement the ISO 9001 quality assurance system.
   (b) This system shall comprise all the participants to the Contract within the Contractor’s teams and its sub-contractors.
   (c) The Quality Assurance Plan shall be based on quality manuals of the Contractor and sub-contractors.
   (d) The Contractor shall nominate from the beginning of the Project, the person in charge of quality assurance of the whole project, who is directly linked to the Project Director.
   (e) The Contractor shall establish from the beginning of the project, the Quality Assurance Plan based on Contractor’s quality system that should define:
      (i) Scope of Quality Assurance Plan, with conditions of validity and revision,
      (ii) Organization retained for the Project with sub-contractors list,
      (iii) The quality plans of the Contractor.

2 Manufacturer Qualifications
   (a) A firm specialized in providing security and access control materials, integrated supervision interfaced with, but not limited to, the following systems: CCTV, FAS, BMS, etc. to that indicated for this Project and with a record of successful in-service performance.
   (b) Manufacturer’s system shall be a standard “off-the-shelf” package utilizing the latest hardware and software technology.
   (c) Any major system development efforts necessary to meet specified requirements are unacceptable.
   (d) Even if this system is a new concept, it shall not require a huge development and shall be based on existing and proven technologies.
3 Maintenance Center

(a) The Manufacturer or factory-authorized agency shall maintain a service center capable of providing training, spare parts and emergency maintenance and repairs for overall system at Project site with eight hours maximum response time.

4 Installer Qualifications

(a) An experienced Installer who is an authorized representative of the equipment Manufacturer for both installation and maintenance of Manufacturer's equipment, and who has completed system installations similar in design and extent to that indicated for this Project, with a record of successful in-service performance.

5 Materials and Workmanship

(a) Materials and workmanship shall comply with the latest issue of all industry standards, publications, or regulations referenced in this Section, including the following as applicable:

(i) Regulations and Standards: System components, parts and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC).

(ii) Compliance with Local Requirements: Comply with applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Engineer, in writing.

(iii) Conform to requirements of referenced industry standards, applicable sections.

6 Source Limitations

(a) Obtain system components from one Manufacturer who shall assume responsibility for system components and for their compatibility.

41.1.8 Warranty

1 Special Warranty

(a) Manufacturer’s Warranty:

(i) Provide written warranty, signed by Manufacturer and Installer agreeing to replace system devices, software and equipment that fail in material or workmanship within the specified warranty period.

(ii) The Manufacturer or factory-authorized agency shall maintain a service center capable of providing training, spare parts and emergency maintenance and repairs for overall system at Project site with eight hours maximum response time.

(b) Installer Qualifications:

(i) An experienced Installer who is an authorized representative of the equipment Manufacturer for installation and maintenance of
Manufacturer's equipment hardware and software, and who has completed system installations similar in design and extent to that indicated for this Project, with a record of successful in-service performance.

(c) Materials and workmanship shall conform to the latest issue of all industry standards, publications, or regulations referenced in "Regulation and Standard" Article.

(d) Source Limitations:
   (i) Obtain system components from one manufacturer who shall assume responsibility for system components and for their compatibility.

2 Experimental Period

(a) There shall be an experimental period of 90 days after successful testing and commissioning of the system, but before issuance of substantial completion certificate. During this period, the Contractor shall undertake supervision and responsibility for operation of the system under actual site conditions. If any malfunctioning or anomaly is noted on the system during this period, it shall be attended immediately. The experimental period will restart automatically from the date of clearing such troubles and start normal operation.

(b) During the experimental period, the Contractor shall undertake supervision and responsibility for operating the system.

(c) After the satisfactory completion of this period, the System is to be taken over by the Employer, as per Contract Conditions, whereby the warranty period is to commence.

3 Warranty Period

(a) Two (2) years from date of Substantial Completion of the SACS.

(b) During the guarantee period, the Contractor shall provide, at its own cost, all required spare parts needed to replace existing components unless it is proved that the component to be replaced was damaged by abuse.

4 Manufacturer Product Performance

(a) The Contractor shall provide a Manufacturer endorsed and backed extended 10-years product, performance, application, and labor warranty which shall:
   (i) Warrant against defects in materials and workmanship (extended product warranty) for a period of ten (10) years.

(ii) Warrant that all cabling components of the installed system will meet or exceed the specifications of TIA/EIA 568B and ISO/IEC IS 11801 (performance warranty) for a period of ten (10) years.

(iii) Warrant that all unshielded/shielded twisted pair cabling links/channels will meet or exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of ten (10) years.

(iv) Warrant that all fiber links/channels shall meet or exceed the loss and
bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of 10 years.

(v) Warrant that the system shall be application independent and shall support both current and future applications that use the TIA/EIA 568B or ISO/IEC 11801 component and link/channel specifications for cabling (application warranty), for a period of 10 years.

(vi) Warrant that all labor attributable to and required by the above shall be supplied at no cost to the Employer for a period of 10 years.

41.1.9 Commissioning

1 Purpose

(a) The purpose of the commissioning phase is to check the equipment according to its elementary function.

(b) During this phase the equipment is powered and the automation and networking are gradually integrated layer by layer.

(c) Mock-up of all types of doors shall be provided in order to verify all the requested functionalities (To be defined with the Employer).

2 Tests: Those tests are divided into 2 sub-phases:

(a) Preliminary Testing:

(i) Mechanical:

1) Mechanical tests,

2) Calibration of the sensors.

(ii) Automatism / Electrical:

1) Powering tests with and without electricity,

2) Control of input/output,

3) Control of the safety measure either personal or material,

4) Test of local mode operation.

(iii) Network / Software Tests:

1) Test of the network,

2) Test of the supervision workstation user interface,

3) Test of the portable terminal user interface.

(b) Test of the System:

(i) The tests performed during this phase are performed with and without loading conditions.

1) Testing the crippled mode (Safe shut down consecutive to loss of energy, etc.).

41.1.10 Maintenance

1 Maintenance Service
(a) The Manufacturer or factory-authorized agency shall maintain a service center capable of providing spare parts and emergency maintenance and repairs for overall system at Project site with eight hours maximum response time.

2 Repair Time or MTTR

(a) The Contractor must commit himself to the following performance that will be checked during the warranty period:
(i) Time for putting back into service the SACS after a problem occurs.
(ii) The monthly average of this time shall be lower or equal to 6 minutes for each device.
(iii) Time to put in place technical and human means to overcome a failure.
(iv) When a technical breakdown requires a time of putting back into service superior to 45 minutes, the Contractor shall apply the technical and human means necessary/required to overcome the failing (resumed by the expected service) during the time of the repair.

(b) The MTTR shall not exceed 30 minutes. The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing time on site, but shall exclude the response time.

(c) The Contractor’s response time shall not exceed 1 hour. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at where the faulty equipment is located.

3 Maintenance Performance Data

(a) The Contractor shall be committed to the three main sizing data of maintenance:
(i) Annual number of hours of preventive maintenance,
(ii) Annual number of hours of corrective maintenance,
(iii) Average annual cost of spare parts (average based on ten years).

41.1.11 Spare Parts And Extra Materials

1 Generalities

(a) The Contractor shall provide the Manufacturer recommended spare parts for all major components in the system for two years fault free operations.

(b) However a minimum of 2% peripherals of each type installed, but not less than one from each type, shall be included in the deliverable irrespective of Manufacturer recommendation.

2 Spare Parts

(a) During the guarantee period, the Contractor shall provide, at his own cost, all required spare parts needed to replace existing faulty components unless it is proved that the component to be replaced was damaged by abuse, the replacements of the faulty components with a new one shall be
done within three days maximum from the date of the faults happening.

3 Extra Materials

   (a) Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels clearly describing contents.

   (b) SACS Devices:
       (i) The quantity of extra materials to be supplied by the Contractor will be proposed and quoted by the Contractor at the tender stage.
       (ii) Dedicated Card Readers shall be provided at selected locations (the exact locations may be agreed during construction stage) for Time and Attendance purposes.

   (c) Test Equipment:
       (i) Provide, together with an itemized list, all test equipment and tools required for routine maintenance, safety checks, and equipment repair.
       (ii) Deliver test equipment and tools at the same time as the system equipment.

41.2 PRODUCTS

41.2.1 Sacs Software Specification

1 Software Generalities

   (a) It shall be designed specifically for security applications and shall provide for polling and demand requests to monitor status, processing alarms according to priority, controlling and processing communications with operator work stations, and synchronizing all system activity.

   (b) System software shall permit point additions and deletions, activation and deactivation, and system reprogramming by authorized personnel.

   (c) The software licence shall not be limited and shall be opened for any number of users.

   (d) The software application shall be working on popular and user-friendly platform.

   (e) Application software shall provide the following operating features:
       (i) Door-by-door basis; lock or unlock doors according to a day and time schedule or an event-initiated program.
       (ii) The software shall allow manual control of selected inputs, outputs and groups of outputs. Manual control shall include pulse and energize/de-energize options for output points and shunt/unshunt options for input points.
       (iii) Door-by-door and individual cardholder basis; permit access to a limited group of cardholders according to a day and time schedule, operator command, or an event-initiated program.
       (iv) Provide for the creation of up to 8 time zones, 50 time and day schedules, with up to 30 holidays assignable to each schedule.
(v) Provide for an individually and adjustable alarm shunt time delays for entry and exit for each door.

(vi) Provide the capability to lockout all users for a certain number of minutes after a certain number of invalid logs on attempts.

(vii) Modify access control privileges of individual cards.

(f) It shall include, validation based on time of day and day of week, holiday scheduling, site code verification with card validation override, video image storage and retrieval of cardholder photographs, and access validation based on positive verification of card, card and video recognition.

(g) The method of communication from remote locations to the central components shall be transparent to the user.

(h) Flexibility: Software will be flexible and source code will be available to allow the maintenance operator to reconfigure the system at site.

2 Software Main Functionalities

(a) Anti-Pass Back Functionality (APB):

(i) System shall have global and local anti-pass back features, selectable by location. System shall support hard and soft anti-pass back.

(ii) Hard anti-pass back: Once a credential holder is granted access through a reader with one type of designation (IN or OUT), the credential holder may not pass through that type of reader designation until the credential holder passes through a reader of opposite designation.

(iii) Soft anti-pass back: Should a violation of the proper IN or OUT sequence occur, access shall be granted, but a unique alarm shall be transmitted to the control station, reporting the credential holder and the door involved in the violation. A separate report may be run on this event.

(iv) Timed anti-pass back: The system prevents an access code from being used twice at the same device (door) within a user-defined amount of time.

(v) The anti-pass back schemes shall be definable for each individual door.

(vi) The Master Access Level shall override anti-pass back.

(vii) System shall have the ability to forgive (or reset) an individual credential holder or the entire credential holder population anti-pass back status to a neutral status.

(b) Operator Authentication:

(i) Multilevel Password Protection: Control operator access to system controls through 10 password-protected operator levels. System operators and managers with appropriate password clearances shall be able to change operator levels for operators.

(ii) Software Tamper:

1) Annunciate a tamper alarm when unauthorized changes to
system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.

2) Annunciate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond their authorization level.

3) Maintain a transcript file of the last 5,000 commands entered at the each server to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.

4) Allow only acknowledgment of software tamper alarms.

(iii) A minimum of 15 passwords shall be available with the system software. System shall display the operator's name or initials in the console's first field. System shall print the operator's name or initials, action, date, and time on the system printer at login and logoff.

(iv) The password shall not be displayed or printed.

(v) Each password shall be definable and assignable for the following:
1) Commands usable,
2) Access to system software,
3) Access to application software,
4) Individual zones that are to be accessed,
5) Access to database.

(c) System software shall provide the following reports:
(i) Alarm history consisting of acknowledged alarms.
(ii) Badge history including access attempts by valid, invalid, lost, and suspended badges.
(iii) Operator history consisting of database changes and log-ins by operators.
(iv) A query functions to allow selected data to be sorted on not less than 3 selection criteria.

(d) Badge Designing Function:
(i) A badge designing function is to be provided to retrieve picture and chose card background.
(ii) The software shall be able to take picture and arrange it in the database.

(e) Operator’s Command:
(i) Tasks that are executed by operator's commands shall include the following:
1) Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
2) Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator can not disable tamper
3) Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.

4) System Test: Allows the operator to initiate a system-wide operational test.

5) Zone Test: Allows the operator to initiate an operational test for a specific zone.

6) Print reports.

7) Change Operator: Used for changing operators.

8) Others to be configured.

(f) Card Expiry Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

(g) Reconfirmation:
   (i) Any important activation of important control functions shall be subject to a reconfirmation.

(h) Administration:
   (i) This software is used by an authenticated administrator in order to mainly:
      1) Look after the whole access control system,
      2) Remotely configure equipment (local intelligent panels, for instance),
      3) Download rules or personal profiles into the controllers,
      4) Receive alarms from the different components of the Security and Access Control System (CU, Card Readers, doors, etc.),
      5) Act as a gateway between the CCTV system, the FAS, BMS and others systems and the SACS.

   (ii) Entry-Control Commands:
      1) Lock (secure) or unlock (open) each controlled entry and exit up to four times a day through time-zone programming.
      2) Arm or disarm each monitored input up to four times a day through time-zone programming.
      3) Enable or disable readers up to twice a day through time-zone programming.
      4) Enable or disable cards up to four times per day per entry point through access-level programming

   (iii) Command Input Errors:
      1) Show operator input assistance when a command cannot be executed because of operator input errors. Assistance screen shall use plain-language words and phrases to explain why the command can not be executed. Error responses that require an operator to look up a code in a manual or other document are not acceptable. Conditions causing operator assistance messages include the following:
a) Command entered is incorrect or incomplete.

b) Operator is restricted from using that command.

c) Command addresses a point that is disabled or out of service.

d) Command addresses a point that does not exist.

e) Command is outside the system’s capacity.

(iv) Authentication:

1) The software shall provide authentication of the system administrators using multi-level password protection, with user-defined operator name/password combinations.

2) Name/password log-on shall restrict operators to selected areas of the program.

3) Provide the capability to lockout all users for a user-definable number of minutes after a user-definable number of invalid log-on attempts.

(v) Override Groups Containing I/Os:

1) System shall incorporate override groups that provide the operator with the status and control over user-defined "sets" of I/Os with a single icon.

2) Icon shall change automatically to show the live summary status of points in that group.

3) Override group icon shall provide a method to manually control or set to time zone points in the group.

4) Override group icon shall allow the expanding of the group to show icons representing the live status for each point in the group, individual control over each point, and the ability to compress the individual icons back into one summary icon.

(vi) Alarms:

1) When an access alarm occurs, the operator in front of the workstation reset the alarm once the door is known.

2) Security personnel shall go to the concerned door and check the status of the door and report to the operator who initialized the inspection of the door in alarm.

3) Alarm System Setup:

   a) Assign manual and automatic responses to incoming point status change or alarms.

   b) Automatically respond to input with a link to other inputs, outputs, operator-response plans, and unique sound with use of WAV files, and maps or images that graphically represent the point location. A direct zoom shall pop up on to the screen.

   c) 80-character message field for each alarm.

   d) Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage
capacity of up to 30,000 messages. Setup shall assign messages to [access point] [zone] [sensor] <other alarm originating device>. This can be configured.

e) Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.

f) Allow secondary messages with a field of lines and characters each.

g) Store the most recent 1,000 alarms for recall by the operator using the report generator.

(vii) Time and Attendance:

1) Time and attendance reporting shall be provided to match IN and OUT readings and display cumulative time IN for each day and cumulative time IN for length of the report.

2) Time and attendance reporting shall be provided to match IN and OUT readings and display cumulative time OUT for each day and cumulative time OUT for length of the report.

3) System software setup shall allow designation of selected access-control readers as time and attendance hardware to gather the clock-in and clock-out times of the users at these readers.

   a) Reports shall show IN and OUT times for each day, total IN time for each day, and a total IN time for period specified by the user.

   b) Reports shall show IN and OUT times for each day, total OUT time for each day, and a total OUT time for period specified by the user.

   c) Allow the operator to view and print the reports, or save the report to a file.

   d) Alphabetically sort reports by the person's last name, by location or location group. Include all credential holders or optionally select individual credential holders for the report.

(viii) System Programming:

1) It shall be user friendly, and capable of being accomplished by personnel with no prior computer experience.

2) The programming shall be MENU driven and include on-line "Help" function or "Tutorial" information, as well as online data entry examples.

3) The system shall provide both supervised and non-supervised alarm point monitoring. Upon recognition of an alarm, the system shall be capable of switching CCTV cameras that are associated with the alarm point in less than 300 ms.

4) The system shall be capable of arming or disarming alarm points both manually and automatically, by time of day, and day of week.

5) The SACS Server shall be designed for full security and access
6) In case of fire detection the system receive input from interface point with fire alarm system then it make release locks for all escape exit.

7) In case of power fail the system will make two strategies:
   a) Fail Safe: System release all locks of unsecured- areas that should be open when power fail.
   b) Fail Secure: System will close all locks of area that considered very high secure area.

(ix) Languages:
   1) The languages used shall be Arabic and English.
   2) Engineering information could be provided in English only.

(i) Security Check Point Workstations:
   (i) On the SCP Workstation, it will be possible to see the profile of the cardholder who is using his/her card to enter a more secured area.
      1) If the Card is valid, the supervision will automatically pop up the cardholder personnel ID file to check the cardholder (this function can be deactivated).
      2) If the card is not valid for any reason (card no longer valid, stolen card, fake card, etc.) the supervision will pop up automatically the ID file of the cardholder who is trying to enter the area or will send an alarm locally and to the main SACS supervision.
   (ii) This Workstation can be seen for instance as a Web-Server though Internet Explorer.

(j) Discreet Alarm:
   (i) Discreet alarm system shall be monitored on the supervision.
   (ii) A special symbol shall be used to represent the discreet alarm push button.

3 Graphical User Interface

(a) The Graphical User Interface (GUI) shall provide operator interface:
   (i) Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.
   (ii) When viewing and controlling inputs, displayed icons shall automatically change to the proper icon in order to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.
   (iii) Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.
   (iv) Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the
operator.

(v) The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.

(vi) Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:

1) Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.

2) Maps to provide real-time display animation and allow for control of points assigned to them.

3) System to allow inputs, outputs, and overrides groups to be placed on different maps.

4) Software shall allow changing the order or priority in which maps will be displayed.

(vii) General Schematic Diagram:

1) General schematic diagram of the SACS architecture shall be available showing all items of the system.

2) In case of any default, the faulty item shall be highlighted for a better operator understanding.

(b) SACS Supervision Workstations:

(i) On the workstation in the Building Management room, an automatic zoom shall be done on alarm.

(ii) When the door is monitored through a CCTV camera, the symbol of a camera shall appear and four tabs shall appear on the screen:

1) General view of the controlled area including, access, location of cameras, type of doors' readers, etc.

2) Historical record of all alarms.

3) Schematic diagram of the system with the visualization of the equipment in default.

4) Inhibition of the badge reading on DC demand through software request.

(iii) It shall be possible to control several PTZ cameras from different workstations using digital pad controller.

(iv) General supervision shall be displayed on several screens for readability matters.

(c) CCTV Supervision Workstations:

(i) Management stations shall be industry standard PC's each with a minimum specification or latest version at the time of purchase.

(ii) CCTV supervision workstations shall be using the same software as the SACS but instead of having all information it shall be looking after all CCTV cameras, PTZ and fixed, for operation and security or others.
(iii) The background layout of the GUI shall be exactly the same as for the SACS and shall propose intuitive graphics to help the CCTV operator knowing which camera is located where.

(iv) It shall allow the control and the display of each camera on the monitor(s) located in front of him.

(d) The GUI shall provide color graphics:

(i) Editor shall allow the generation of custom dynamic graphics for graphical representation of the card access system.

(ii) The editing menu shall provide help menus for selecting graphics, choosing colors, copying previous graphics, and deleting data points.

(iii) Each type of door should be different as a symbol and/or color and be dynamic upon state.

(iv) Information on the color graphic display shall be dynamic and automatically updated.

(v) Provide the capability of linking high level maps with lower level (more detailed) maps and vice-versa.

(vi) The Contractor shall propose an essential background for SACS and CCTV showing the essential information for the user to know where he is.

(e) Display Graphics:

(i) Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 3 (three) seconds from time of operator command.

(ii) "Help" request within the system operation:

1) Included in main menus.

2) Provide unique, descriptive, context-sensitive help for selections and functions with the press of one function key.

3) Provide navigation to specific topic from within the first help window.

4) Help shall be accessible outside the applications program.

(iii) Reports shall have the following options:

1) On screen view.

2) Print to System Printer: Include automatic print spooling and "Print To" options if more than one printer is connected to system.

3) "Save to File" with full path statement.

4) System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of time zone, manually overridden, not reporting, or in alarm.

(f) Display of Elements:

(i) All Elements regarding Security and Access Control System shall be represented on the layout of the supervision. These elements are at
least:
1) Card Readers,
2) CU,
3) Server,
4) PTZ and Fixed camera,
5) All supervision,

(ii) Depending on the password, it shall be possible to change and configure features from any workstation.

4 Card Enrolment Software

(a) Special enrolment software shall be provided. A dedicated workstation shall be proposed for this purpose.

(b) Specifications and enrolment functionalities and procedure shall be provided for the Employer approval. Cardholders enrolment planning shall be provided for the Employer approval.

(c) Special security treatment shall be provided.

(d) Key Encryption for HF transmission during enrolment,

(e) Read and Write Key in operation mode,

(f) Read and Write Key for data storage in the Smart Card.

(g) The enrolment station shall not have alarm response or acknowledgment functions.

(h) The SACS software shall provide for multiple password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrolment functions.

(i) The program shall provide means to disable the enrolment station when it is unattended to prevent unauthorized use.

(j) The program shall provide a method to enter personnel identifying information into the entry-control database files through the enrolment station. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs.

(k) Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:

(i) CARD MAPPING: Determines a specific format that data must comply with.

(ii) REQUIRED: Operator is required to enter data into field before saving.

(iii) UNIQUE: Data entered must be unique.

(iv) DEACTIVATE DATE: Data entered will be evaluated as an additional deactivated date for all cards assigned to this cardholder.
(v) NAME ID: Data entered will be considered a unique ID for the cardholder.

(l) Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.

(m) Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.

(n) Card Mapping Requirements:

(i) The mapping of the card shall store, at least, the following information:

1) Serial number of the card (hardware),
2) Name and ID folder of the card holder,
3) Validity of the card,
4) Pin code number,
5) Anti-pass back writing zone,
6) Working service or group,
7) Key encryption for read and write using 3DES encryption,
8) Other free writing spaces that shall be used at any time with specific W/R key.

(ii) All W/R keys are the proprietary of the Employer and shall be hold in a secret place on different hardware support (at least 2).

5 Technical Specifications

(a) Operating System: At least Windows XP; to be confirmed by the Employer.

(b) Specific Developments:

(i) No hard specific development is allowed for the software.

(ii) The software is to be proven and installed for other project of the same size.

(c) Software and GUI and HMI background of the whole controlled area shall be compliant with at least WMF, DWG, JPEG, and BMP and shall take into consideration the Architectural Drawings and layout of the controlled area. Proposal shall be provided to the Employer for his approval and agreement.

41.2.2 Operation Design and Components

1 Generalities

(a) Servers, PC workstations, printers, etc. shall be from one of the most reputed PC Manufacturers and the Contractor’s choice shall be coordinated with the Employer.

2 Workstations

(a) Real Time Functions:
(i) The color monitor and keyboard for each workstation shall display real-time data, allow operator's commands, and report system activity. Monitors shall be at least 17” TFT screen. It shall be designed to work 24 hours a day.

(ii) The host work station shall function as the system programmer's and system operator's work station, for entering and editing the system database, entering operating software, and monitoring the operation of all system functions.

(b) Operator Work Station: In order to provide the best up-to-date equipment at the lowest price and to manage the maintenance at the best level, the Contractor shall specify their requirements to the Employer's IT department.

(c) Alarm Output:
   (i) The output of alarm displays shall depend upon the relative priority of each alarm.
   (ii) The system shall automatically prioritise alarm displays.

(d) Format: The format shall include a dedicated and protected area of the viewing screen for the current date and time.

(e) Video Recall Facility: All SACS workstations shall have video recall facility, and the graphics shall allow viewing live video and controlling the alarmed cameras.

(f) Advisory Messages: Each workstation monitor shall display system advisory messages upon hardware malfunction or restoration in a dedicated and protected area of the viewing screen.

(g) Power Supply: Provided from the UPS system in the UPS Room as shown on drawings in order to allow normal continuous operations for 15 minutes or until the emergency generators are online, whichever occurs first. The Contractor shall be responsible for power connectivity and shall make sure that the available UPS capacity is adequate to provide the required autonomy.

(h) Access Rights: The usage of workstation for any function shall be purely based on access rights of the user defined by his password.

(i) Flexibility: Workstations shall be fully flexible. Their function can be adapted at any time depending on the authorisation password.

(j) Communication: Communication between servers and workstations must use a PKI mechanism and allows HTTP protocol.

3 Data and Alarm Laser Printer

(a) Printer:
   (i) A laser printer shall be provided for each primary and secondary workstation for hard copy alarm printouts and system malfunction report.
   (ii) The laser printer output shall be the latest version on the market.
   (iii) All printers shall be heavy duty, suitable for 24 hours operation.

(b) Printer Characteristics:
   (i) Each printer shall have a buffer memory to permit operation at
communication rates up to 10 Mbps.

(ii) Printers shall communicate over the latest interface.

(iii) The minimum characteristics will be:

1) Format: A4 and A3.
2) Printing speed: 50 p/min (B/W), 15 p/min (color).
3) Resolution: 600 x 600 (B/W), 500 x 500 (color).
4) Drawer: 100 sheets.
5) Additional drawer of 500 sheets.

4 Card Printer

(a) Card Printer:

(i) The card printer shall be provided for the enrolment workstation for printing out facial of the card regarding the mapping in the SACS supervision.

(ii) The printer output shall be the latest version on the market.

(b) Printer Characteristics:

(i) The printer shall be compatible with all cards ISO standards related to physical and temperature requirements.

(ii) The printer shall be of double-sided printing with multiple layers.

(iii) The printing rate shall be, at least, 5 cards/minute.

5 Enrolment Camera

(a) Enrolment Camera:

(i) The enrolment camera shall be provided for the enrolment workstation.

(ii) It shall be directly connected to the enrolment workstation using Ethernet or the serial port of the station.

6 Communication Network

(a) Communication:

(i) All communication between the host workstation, secondary workstations, and the access control panels shall be via digital transmission through the network.

(ii) Provide the following communication options: RS-485 or Ethernet TCP/IP or the latest open communication protocol.

(b) Data Transmission: The data transmission rate between the workstations and the servers shall be bi-directional using TCP/IP VLAN network.

7 Server

(a) Redundancy:

(i) The system shall be based on two servers (one being hot redundant
on the other one), and several clients.

(ii) Communication between the servers and the clients' workstations must be based on TCP/IP and HTTP, using any standard Internet navigator.

(b) Hardware Fault Tolerance: Redundant hardware design shall include either Dual-Modular Redundancy (DMR) or Triple-Modular Redundancy (TMR) models to protect users' applications from component outages.

(c) Software Availability:

(i) The server must prevent outages and minimize downtime related to software issues.

(ii) Integrated Service Technology: The Server shall provide proactive service to feature system detect emerging problems early to help keep the system and application online during troubleshooting, repairs, or upgrades.

(d) Interfaces with the Server shall be taken into consideration at the design stage and discussed with the Employer.

(e) Furniture:

(i) In order to provide the best up-to-date equipment at the lowest price and to manage the maintenance at the best level, the Contractor shall provide his requirements to the Employer's IT department.

(ii) The minimum characteristics will be:

1) Bi-processor cluster with highest speed available on the local market.

2) Highest available RAM capacity.

3) 8 disks RAID 0+1, minimum 320 GB capacity.

4) External Controller RAID.

8 Card and Chipset

(a) The amount of required cards will be given at a later stage.

(b) Standard: ISO 14443 type A/B.

(c) Card Format: Compliant with ISO 7810, 7811, and 18555.

(d) Reading Distance: At least 5 cm; the Contractor shall be responsible to eliminate all the effect and the influences of the metallic supports affecting the reading distance of the Card Reader.

9 Controller Unit Functionalities

(a) Functionality:

(i) The Door Controller (DC) is a microprocessor-based device, which supports the operation of card access and security monitoring hardware.

(ii) Each DC shall be capable of independent operation should a loss of communication with the workstations occur.

(iii) Each DC shall support the operation of access control card readers, electric door locks, door and other digital alarm devices, and door exit
devices.

(iv) Modular expansions shall be available for one (1) to four (4) supplementary access.

(v) The number of alarm transactions and access transactions a DC shall be capable to store shall be mentioned by the Contractor.

(b) Required Software:

(i) Required software shall be resident in the DC.

(ii) This shall include approved card access codes for each reader and the door unlock times for each door connected to the DC.

(iii) Approved card codes and door unlock times may be updated through the workstations.

(iv) The DC software shall allow direct control of the output relays and input status ports through the workstations.

10 Controller Unit Specifications

(a) Technical Features:

(i) The DC shall provide the minimum features rated below:

1) Ambient Operating Temperature: -10° C to 60° C.

2) Ambient Humidity: 10% RH to 90% RH (non-condensing).

(ii) The DC shall be communicating through Ethernet TCP/IP protocol using unique Mac address for central configuration.

(iii) Allow for redundancy for essential controllers.

(iv) Controllers shall be modular, each supporting up to 8 Card Readers. 25% spare shall be available in each controller.

(v) Controllers shall the capability to support I/O Card of 128 monitored digital input points and 32 digital output points.

(vi) Any DC, on all floors, which uses a volatile memory, will be energized through the UPS system in the UPS room as shown on drawings, except for the DC’s located in the IT room which will be energized through the UPS system in the IT room. The Contractor shall be responsible for power connectivity and shall make sure that the available UPS capacity is adequate to provide the required autonomy (minimum 15 minutes).

(vii) Detection circuits supported by the DC shall be supervised.

(viii) The DC shall have fast communication response time to achieve the security requirements as specified.

(ix) It shall have the ability to operate in local decision mode in case of any communication loss with the main DC.

(x) Hardware and Software:

1) The hardware and software of the DC shall have at least the capability of saving and downloading databases, remote data analysis, allowing or prohibiting the access through physical aids, transferring data with other communication means and printing.
(xi) In local mode, the Controller shall also retain the access and alarm events (minimum 10,000 events), and shall download the data to the main Server upon restoration of communication.

(xii) The DC shall be microprocessor based and shall include dynamic and static memories with enough capacity to cater for all the required databases. The system-controlled components shall be grouped in one enclosure with power supply; self power regulation, heat dissipation ventilators, self-protection against power failures, surges and the like.

(xiii) It should be capable of controlling relay outputs (number to be clarified by the Manufacturer).

(xiv) DC shall have serial and parallel ports as well as Ethernet or TCP/IP. Communication with Card Readers should be achieved with twisted pair shielded cables and cable length limitation shall be at least 150 m.

(xv) Accessories shall include at least, but not limited to, diagnostic LED for status indication (ON, OFF, FAULT), data processing flashing LED and ports status LED (TRANSFER, DISABLED, FAULT).

(xvi) The modular multitask units shall:
1) Constantly control the status of equipment.
2) Collect information.
3) Send data to workstations.
4) Work as independent processors.
5) Use a high level programming language, ensuring reliability, future extension, etc.
6) Capability and easy of maintenance.

(xvii) Each unit shall contain:
1) Communication interfaces,
2) Universal digital input, digital output controls,
3) Universal analog input, analog output controls,
4) A plug-in communications module for maintenance,
5) A friendly language display,
6) Built-in time reminder functions to ensure that special maintenance requirements will be steadily annunciated,
7) Self-diagnostic system,
8) Voltage switching relays.

(xviii) The Central Memory Unit shall perform the following functions:
1) Connection of the programming console (directly, or via the network),
2) Running of the application program,
3) DC operating mode control,
4) Time stamp,
5) Control of 5 ms to 1 second programmable watchdog device,

(xix) The program memory is a non-volatile RAM type memory battery safe.

(xx) Each DC shall include a main supply for its electronic components and an inside special one for low current, towards sensors or other processing systems required.

(xxi) In case of network cut-off downwards the workstations, the DC and programmable modules shall keep on the recorded data.

11 Card Reader Functionalities

(a) Main Functionalities:

(i) Each Card Reader shall be intelligent and of the "Proximity" digital operation technology to be able to read the following standard without any hardware modifications:

1) 13.56 MHz (ISO 14443 A/B and 15693).

(ii) Each Card Reader shall communicate directly back to the access control panel.

(iii) The Card Reader must operate over shielded cable using both Wiegand and RS-485 or IP Protocol without any additional power supplies.

(iv) The Card Reader shall communicate to the access control panel in a supervised mode of communications. In the event of a reader malfunction, it shall be capable of being detected by the access control panel and an alarm must be generated at the workstations.

(v) Full error checking shall be provided within each reader prior to sending the information to the access control panel.

(vi) The installation of Card Reader will be implemented to cope with handicapped persons requirements and standards.

(vii) They shall have the capability of being programmed to activate a built-in multicolor LED. Light on the front face of the reader to indicate, at least:

1) The great working of the reader,
2) The accept of the badge,
3) The refusal of the badge,
4) Optional: Ideogram screen panel to show the user how to proceed with his/her card.

(viii) Alarm shall be generated and reported to the supervision station in case of reader tampering.

(ix) Reading the badge information without contact.

(x) The read distance of a badge shall be at least 5 cm.

(xi) Any technical defaults from the reader shall be forwarded to the Controller Unit.

(xii) To inform the user, visual and sound information must be provided on the reader. It shall be possible to inhibit this feature.
12 Card Readers Specifications

(a) Characteristics:
   (i) The minimal distance between two badge-readers shall be provided in order to prevent electromagnetic interference.
   (ii) Standard communication protocol required:
         1) Full duplex protocol such as IP, RS-485 or RS-422.
         2) Simplex communication protocol such as Wiegand, Clock/Data or any equivalent open protocol.
   (iii) Different sizes shall be available; the maximum size shall not exceed 150 x 150 mm.
   (iv) Card Readers shall support proximity digital cards of dual technology compliant with ISO 14443 A or B Standard and ISO 15693 (with a reading range of at least 70 cm).
   (v) All readers shall be weather resistant, suitable for indoor or outdoor use and use tamper proof screws for installation.
   (vi) Readers shall be rated for operation at a temperature range of -30 deg. C to +65 deg. C and a humidity range of 0% to 100% RH, non-condensing.
   (vii) Card Readers shall comply with international Electro-Magnetic Interference, EMI, regulations and shall have fast reading and data transferring process and shall communicate with the system controller via shielded twisted pair cables.
   (viii) A built-in tamper switch contact within the reader is required.
   (ix) Card Readers shall have esthetical shape, be weatherproof and indoor type, tropical proof and tamper proof. Outdoor type readers shall be suitable for outdoor mounting, UV and salinity proof.
   (x) Card Readers shall have a built-in buzzer and LED for a better understanding of the user.

13 REX Switches (Push Button)

(a) REX Switches (Request-to-Exit): Momentary-contact back-lighted REX switches, with stainless-steel switch enclosures.
   (i) Enclosures: Flush or surface mounting. REX shall be suitable for flush mounting in the switch enclosures.
   (ii) Enclosures shall additionally be suitable for installation in the following locations:
         1) Indoors, controlled environment,
         2) Indoors, un-controlled environment,
         3) Outdoors.

(b) Power: REX switches shall be powered from their associated Controller, using dc control.

14 Door Contact Switch
(a) Door Position Switch (Contact): Magnetic type, flush mounted on the door to provide potential-free output for the controller.

15 Door Hardware Interface

(a) General:
   (i) The Contractor shall provide suitable devices for each door type for Security and Access Control Systems.
   (ii) Coordinate with doors, frames, and hardware specified in other sections.
   (iii) Provide all equipments related to SACS such as, but not limited to, CR, DC, lock, and other accessory parts necessary to complete the installation.
   (iv) Provide all necessary components to supply power to devices from building power distribution system.
   (v) All the wiring and equipments surrounding the access shall be hidden and implemented in the most secured area or side. They shall also be integrated in the design as per architectural specifications.

(b) Panic Exit Devices and Fire Exit Devices with Alarm (Break Glass): Operation of the exit device shall generate an alarm and annunciate a local alarm.

(c) Exit Alarm: Operation of a monitored door shall generate an alarm.

(d) Electric Door Strikes: Use end-of-line resistors to provide power line supervision. Signal switches shall transmit data to Controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and shall report a forced entry. Power and signal shall be from the Controller.

(e) Electromagnetic Locks: End-of-line resistors shall provide power line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the Controller.

16 Sequence of Operation

(a) Sequence of Operation for Access with Card Reader:
   (i) If the card is valid, the door's magnetic lock is released, and the opposite Card Reader will be disabled for the operating time.
   (ii) If the door is not pushed/opened within a pre-defined time ($X = 4$ sec.), the door will be locked again and the cardholder will be considered outside.
   (iii) If the door is opened during the pre-defined time ($X = 4$ sec.):
      1) Door contact will give a signal to the SACS that the door is opened through the door contact,
      2) After a pre-set time ($Y = 10$ sec.), the door should be closed; if not an alarm will be initiated at the SACS "Door Open Too Long", a local alarm will be raised in the buzzer, the correspondent CCTV camera monitoring the specific door (if any), will pop-up to the alarm CCTV monitor.
   (iv) The Card Reader shall go to its initial stage after the door is closed.
(v) Login to the system will be done only when the door is open.

(vi) Sequence for infracted door or operated without a valid card:

1) Instantaneous alarm signal activated at the SACS "Door Forced to Open" + local alarm + pop up of the CCTV camera (if any).

2) Instantaneous local buzzer alarm shall be activated.

3) Buzzer alarm shall only be deactivated with a valid card at the alarmed Card Reader or through the central supervision workstation.

(b) Sequence of Operation for doors having a Card Reader on one side and REX on the other side:

(i) Same as above, but when to exit the personnel needs to push the exit button to instantaneously open the door to exit.

(c) Note: A Card Reader has to unlock the 2 wings of the door, if double leaves doors are controlled.

(d) Doors with Panic Bar and Card Reader:

(i) In case the Panic Bar is pushed:

1) For the first 3 seconds, an internal alarm in the Panic Bar will be activated (without sending any signal to the SACS) and door will be kept closed.

2) If the Panic Bar is kept pushed for more than 3 sec., the local system alarm sounder shall be activated.

3) The door lock will be released even if the Panic Bar has not been kept pushed for the next 15 sec. In this case, an alarm signal will be send to the SACS.

4) The local alarm will remain activated until a valid card will be attended at the “Alarmed Card Reader”.

(e) Fire Exit Doors – Monitored:

(i) For the first 3 seconds, an internal alarm in the Panic Bar will be activated (without sending any signal to the SACS) and door will be kept closed,

(ii) After the 3 seconds, the door will open instantaneously,

(iii) The door contact will give a signal alarm to the system,

17 Wire and Cable Technical Functionalities

(a) The Contractor shall supply all cable and wire for the following equipment:

(i) From door hardware to Door Controller,

(ii) From AC/DC converter to Door Controller,

(iii) From CR to DC,

(iv) From DCDC to network equipment (in the IDF (HCC) room),

(v) From every workstation to the network equipment,

(vi) Interfaces with other system except when specified.

(b) This includes power as well as communication cables.
Power cable shall be provided by the AC/DC converter with a 240 V ac UPS fused outlet in the IDF (HCC) room.

18 Wire and Cable Technical Specifications

(a) Installation: All wiring and cable shall be installed in metal raceways or within equipment. Conductors within equipment enclosures shall be carefully cabled and laced. Individual conductors shall be tagged with markers indicating the function, source, and destination of all cabling, wiring and terminals. All cables and wires shall be identified, utilising heat-shrink, pre-printed, wire markers.

(b) Number of Conductors: As recommended by system Manufacturer for functions indicated.

(c) Checking and Tests: After installation, and before termination, all wiring and cabling shall be checked and tested to ensure there are no grounds, opens, or shorts on any conductors or shields. A V.O.M. shall be utilized to accomplish these tests and a reading of greater than 20 Mega ohms shall be required to successfully complete the test.

(d) Inspection: Visually inspect wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps except during actual termination. At no time shall any coaxial cable be subjected to a bend less than a 150 mm radius.

(e) Protection:
   (i) Protect wire and cable from kinks.
   (ii) Provide grommets and strain relief material where necessary, to avoid abrasion of wire and excess tension on wire and cable.

(f) Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.

(g) Identification:
   (i) Identify components, conductors, and cables.
   (ii) Color-code conductors, and apply wire and cable marking tape to designate wires and cables so media are identified and in co-ordination with system wiring diagrams.

(h) Raceway: Use communications cable tray wherever possible for low voltage cabling. Exposed raceway below 2.4 meters and in dry locations shall be rigid steel conduit.

(i) Twisted-Pair Cables:
   (i) Cables used in this project shall exceed Category 6 - ISO 11801 - 25N780 performances.
   (ii) All cables shall have the following capacities:
        1) 4 twisted-pair (simplex),
        2) 2 x 4 twisted-pair (scindex). Scindex twist-pair cable may be 2 x 4 pair foiled cable or 2 x 4 pairs with an overall shield.
   (iii) Twisted-pair cable shall have the following characteristics:
1) Nominal Impedance: 100 Ohm +/- 5%, 10 - 250 MHz.
2) Tinned copper AWG23 conductors.
3) 100% overall aluminum foil screened.
4) Low Smoke Zero Halogen outer sheath.
5) Metric marking indication with type of cable, year, ref., number.
6) Ripcord.
7) Tinned copper drain wire.
8) Propagation Speed: 72% c.
9) Propagation Unbalance: 10 ns/km.
10) Weight: 70 kg/km.
11) External Diameter: 8.5 mm.
12) Installation Temperature: -5° C / +40° C.
13) Storage/Transport Temperature: -15° C / +70° C.
14) Operating Temperature: 0° C / +60° C.
15) Complies with IEC 60754-1.
16) Complies with IEC 60332-3C.

(iv) The Contractor may provide other type of twisted-pair cable if characteristics and performance meet the above-mentioned specifications:
   1) F/FTP cable, 4 individually shielded twisted pairs with an overall shield.
   2) S/FTP cable, 4 individually shielded twisted pairs with an overall braid.
   3) UTP cable is not allowed.

(j) RJ45 Connectors/Jacks:
   (i) The Contractor shall use RJ45 9pts connectors complying with Category 6 - ISO 11801.
   (ii) Provide 9 position/8 conductors + 1 drain wire connector.
   (iii) Connectors shall be "faradized" including shielded back cap covering cable screen on 360°.
   (iv) Connectors shall be connected with simple tool allowing simultaneous connection of 4-pairs cable and control of un-twist operation.
   (v) Connectors shall be provided with faceplates for communication outlet in gang widths.
   (vi) Faceplate shall fit with spring shutter and label holder.
   (vii) Given their location and cable function, faceplates shall be as follows:
       1) Green and adapted to patch panel for vertical wiring connectors.
       2) Blue and adapted to patch panel for horizontal wiring connectors.
3) White modular 45 x 45 for terminal wall or floor outlet.

(k) RJ45 Patch Cords:
   (i) The Contractor shall provide Category 6 patch-cords complying with ISO 11801 and able to support Gigabit 1000 Base Tx.
   (ii) Patch-cords shall have the following characteristics:
        1) Impedance: 100 Ohm +/-5% up to 250 MHz.
        2) Stranded conductors.
        3) 4-pairs capacity.
        4) 100% overall aluminum foil screened.
        5) Low Smoke Zero Halogen outer sheath.
        6) Marked each meter.
        7) RJ45 connectors complying with EIA/TIA 568B.
        8) Length: 0.5, 1, 2, 3, 5, and 10 meters.
        9) Labeling through at least 5-colors inserts: blue, yellow, black, red, and green.
   (iii) The Contractor shall supply patch cords in the same quantity for each color.

(l) PE insulated, finely stranded tinned copper conductor, with copper braid screen and PVC over-sheaths.

(m) Power supply and communication cables shall be provided for all equipment of the system: controllers, servers, workstations, and printers.

41.2.3 Interfaces

1 Interface with Systems
   (a) When hardwired interface is not required, software interface between any systems shall be as open as possible using open software communication protocol.
   (b) The Security and Access Control System shall exchange information through the Ethernet LAN network.

2 Interface with Fire Alarm System (FAS)
   (a) The system shall be interfaced with the FAS system through the use of Fire Alarm System control modules. All Emergency Exits monitored or not shall be compliant with NFPA Standards and therefore be "Fail Safe" wired.
   (b) In case of an Emergency Exit controlled by the SACS system, the FAS has priority over security. When zone in alarm has been detected, all security that are used as safety accesses will automatically unlock if the FAS requires so.
   (c) Dry contact from fire alarm (field device) shall be hardwired up to the Door Controller. Sequence of operation shall be in compliance with the NFPA Standards.
   (d) The FAS shall also report the zone in alarm to the SACS system.
(e) In case of confirmed fire, the FAS shall send an order to the SACS controlled doors in the affected zone to unlock them.

(f) As per NFPA requirements, all SACS Emergency Exits shall be directly interfaced by hardwire to the Fire Alarm System.

(g) A software interface is also required with the FAS to primarily provide information on doors that are unlocked due to fire; this information shall be issued by FAS.

(h) The Contractor shall coordinate all interfaces needed with the FAS.

3 Interface with CCTV

(a) The SACS shall be interface with the CCTV management system in order to manage live video access rights of the user. According to each generated alarm, the user such as a Security personnel and so on, shall have access to its own items and not others. Only special access rights shall have access to every alarm and event and shall be able to manage any CCTV camera.

(b) Each workstation managing CCTV camera shall be implemented with SACS software.

(c) On the SACS software, it shall be possible to separate operation from safety, security and so forth, depending on the access rights of the end user, e.g. when a safety operator logs on to his/her computer, he/she shall only have access to safety CCTV cameras.

(d) Each SACS workstation shall include:
   (i) Analog video input card.
   (ii) Network card.
   (iii) CCTV software.
   (iv) SACS software.

(e) The interface with the SACS shall be through dedicated network or LAN depending on the selected technologies and shall allow the control and the local surveillance of each controlled area.

(f) The system shall be capable of "freeze to print" images from CCTV.

(g) Any breaking or violation of access provided with a CCTV camera will automatically switch on to the video monitor or/and pop up a window in the main security supervision (to be configured).

(h) The SACS shall be compatible with the main CCTV system protocol.

(i) All SACS workstations shall have a live video output interface from CCTV system.

4 Interface with BMS

(a) The BMS will be the central interface between other systems.

(b) SACS shall be interfaced to the BMS. The Contractor shall provide the necessary gateways if required.

(c) The interface with the BMS shall provide the following data information:
   (i) SACS main system ON.
(ii) SACS main system OFF.
(iii) SACS main system in Default.
(iv) Status of every single automatic door related to SACS (motor general default or failure).
(v) Status of every controller (On, Off, Default).
(vi) Status of communication between SACS and CCTV (On, Off, Default).

5 Interface with SCN

(a) The system shall be interfaced with the Structured Cabling Network to allow the communication between SACS and all above interfaced systems through the backbone.
(b) Redundancy cabling shall be provided to DC.
(c) The SACS shall be part of a redundant VLAN within the Ethernet backbone network.

6 Interface with UPS

(a) All DC's and other critical components shall be powered by the UPS systems in the UPS room as shown on drawings, except for the DC's located in IT room which will be powered by the UPS system in the IT room. The Contractor shall be responsible for power connectivity and shall make sure that the available UPS capacity is adequate to provide the required autonomy (minimum 15 minutes).
(b) Other equipment, such as, modems, workstations, screens, etc. shall also be powered by these UPS systems.
(c) A 240 V ac UPS power cable shall be implemented with a fused outlet by each access.
(d) All power supply and network interfaces shall be protect against voltage surges due to lighting.

7 Integration of SACS Equipment with Other Trades

(a) The SACS Contractor shall propose Shop Drawings, to be approved by the Engineer, for each typical case of integration, as to avoid mismatches.
(b) The integration of the SACS hardware (equipment, cables and cable routing) within each type of door and doorframe shall be studied in such a way to be done in factory and delivered on site to be ready for installation.
(c) Pre-fabricated and integrated conduits into doors and door frames shall be installed in such a way to allow easy and secure integration of cables and wires.
(d) It is the duty of the Contractor to coordinate with door hardware as to avoid any technical mismatches.
(e) The Contractor shall ensure the full coordination between the SACS constraints and other systems such as Fire Alarm System and CCTV, or any other interfaced system.
(f) All the SACS systems shall be studied, installed and tested in order to offer
an easy maintenance and access.

(g) The coordination due by the SACS Contractor shall cover both hardware and software. It shall also cover all aspects of Shop Drawing elaboration, manufacturing, construction, testing and commissioning, to achieve a comprehensive system in proper and efficient working order.

(h) The final coordination on site with civil works, facades, architecture, HVAC, plumbing, electrical and any other construction aspect, remains the duty of the Contractor.

8 Interface with Power Supply

(a) The power supply necessary for the SACS shall be 240 V ac high quality power supply, connected to UPS only.

(b) An AC/DC converter shall ensure the power supply of all attached SACS equipment as applicable; therefore there is no need for dedicated power supply to individual SACS components.

(c) The power supply cabling, to each related equipment, shall be made only throughout the Door Controller. The Door Controller shall be divided into 2 sections of terminal connectors: power and control.

(d) No direct connections from AC/DC converter to SACS equipment are permitted, without transfer through the Door Controller. As a result, no power supply to individual latches, for example, is permitted by external direct connection. Only SACS control and monitoring equipment can be connected to such dedicated AC/DC converter.

(e) The power supply of each AC/DC converter shall not exceed 500 VA; however, the exact value shall be the result and responsibility of the Contractor in charge of the installation of SACS equipment, as part of his Shop Drawings.

(f) The Contractor shall ensure the power supply of AC/DC converters. Circuits allowing such power supply shall never be mixed with any other system.

9 Cable Routing and Conduits Coordination

(a) Conduits installed inside controlled doors and frames shall be installed directly by the hardware supplier. When transfer hinges are necessary, it shall be also installed by the hardware supplier.

(b) Conduits shall be equipped with draw wires.

(c) Cables necessary for power supply from the AC/DC converter up to each SACS component shall be delivered, installed, and tested by the SACS Contractor.

(d) Equally, all data interconnections from each SACS component up to the common Door Controller shall be delivered, install, and tested by the Contractor.

(e) The Contractor is also in charge for the provision and installation of all additional conduits as to ensure the continuity up to the local Door Controller and AC/DC converter.

10 Interface with Communication Network Active Components
(a) The SACS shall be interfaced with the data switching equipment to allow DC, Server, workstations and other active equipments to communicate through the LAN.

11 Interface with Architectural Design

(a) The SACS shall be interfaced with the architectural design in order to implement:
   (i) Door Controller close to the controlled or monitored point,
   (ii) AC/DC converter close to the controlled or monitored point,
   (iii) All equipment related to the SACS such as CR, etc.

(b) The choice of the location shall be coordinated and submitted to the Employer for approval.

(c) The methodology related to the integration of conduits, Door Controllers, and AC/DC converters, conduits and any SACS equipment within walls, floors, facades and ceilings should be closely coordinate with the architectural design. Therefore, it is the duty of the Contractor in charge of the SACS to ensure the proper coordination with this design and any other involved parties.

(d) When no space is available above false ceiling for the installation of the necessary AD/DC converters and the interface panel, an appropriated space can be found either integrated into the floor or nearby an available wall. However such integration shall be made as to allow easy maintenance during operation.

41.2.4 Power Supply

1 The Contractor shall be responsible for coordination between the different systems and with the electrical works to ensure this power supply source and for a complete operational system. It shall not be allowed to provide a separate power supply panel board for each system's equipment. Specifications of the feeders and of the corresponding panels shall be in accordance with the relevant sections of the electrical Specifications.

2 Main Features of AC/DC Converter

(a) The Contractor shall provide power supply and AC/DC converter for, but not limited to:
   (i) Door hardware (e.g. magnetic lock, flashing light, panic bar, hold open magnet, etc.),
   (ii) All SACS equipment (CU, workstations, etc.),
   (iii) Server,
   (iv) Others as deemed necessary.

(b) Power supply shall use input power of UPS 240 V ac, 50 Hz and output 24 V dc. Output voltage shall be filtered and regulated.

(c) Provide multiple output circuits on individual breakers.

(d) Power supply shall be housed in a key locked enclosure.

(e) 240 V power shall be provided adjacent to the controllers in technical
rooms. It shall not be in junction boxes and Card Readers shall be self powered through the Controller Units.

3 Power Supply for Doors

(a) All SACS equipment shall be connected to common AC/DC converters. This equipment, part of the SACS, shall be energized in 240 V ac, connected to a no-break source, delivered by the power supply system only. Therefore there is no need for any other individual power supply.

(b) Conduits installed inside controlled doors and frames shall be installed directly by the hardware supplier. This also concerns the transfer hinge when necessary. However, cables necessary for power supply from the AC/DC converter up to each SACS components shall be delivered install and tested by the SACS Contractor. Equally, all data interconnections from each SACS components up to the common Door Controller shall be delivered, install, and tested by the SACS Contractor. The SACS Contractor is also in charge for the provision and installation of all additional conduits as to ensure the continuity up to the local Door Controllers and AC/DC converters.

41.3 EXECUTION

41.3.1 Installation

1 General

(a) Scope of Work:

(i) The scope of work shall include, but not limited to, detailed engineering, fabrication and coordination thereof, supply and installation of all above equipment, operator training, hardware, software, wiring, cabling, labor, supervision, management control, testing, commissioning, maintenance and 24 month extended warranty for all supplied equipment.

(ii) Installation shall be supervised and tested by a representative of the Manufacturer of the system equipment. The work shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this work.

(iii) In addition to the above, the Contractor is also expected to supply the following:
  1) Coordination meeting with the Project authorities,
  2) Coordination with all others traders and systems interfering with the design, installation and testing of the SACS,
  3) Progress reports and progress reviews,
  4) Insurance for the transport of the equipment,
  5) Quality assurance setup and management,
  6) Document management,
  7) Configuration management for the duration of the Project,
  8) Off-the-shelf software updates for the duration of the warranty,
9) User documentation and training, including textbooks,

10) Worksite expenses (setup and removal of temporary offices, worksite vehicles, site offices computers, printers, desks, etc.),

11) Archival.

(b) Equipment installation on site is to be limited to the layout and fixation, and inter-wiring of various items of the ready-made equipment.

(c) Acceptance of works is to be restricted to the equipment and installations complying with the approved submittal, approved Shop Drawings, and the agreement of the Engineer.

(d) All installation works, carried out by the Contractor, shall be done under the direct supervision of qualified technicians who are trained and have the relevant experience.

(e) Provide 20 mm, minimum, thick plywood backboard to support the Controller Units (CU) and associated equipment mounted to the wall in each room. Coordinate location and size of backboard with the Engineer prior to installation.

2 Equipment Data

(a) Submit complete technical data including Manufacturer's catalogues and specifications, system description including operational aspects, system features, and components.

3 Shop and Construction Drawings

(a) Submit drawings for approval.

(b) Constraints to be studied by the Contractor as part of its necessary Shop Drawing development include:

(i) The classification of SACS at controlled points does not take into account any materials or specific manufacturing. It refers only to functionalities and equipment to be installed on each side.

(ii) When no space is available above false ceiling for the installation of the necessary AD/DC converter and the interface panel, an appropriated space can be found either integrated into the floor or nearby an available wall.

(iii) The integration of the SACS hardware (equipment, cables and cable routing), for each case of door manufacturing, shall be studied in such a way to deliver on site a package ready for installation.

(iv) It is the Contractor’s duty to coordinate with door hardware as to avoid any technical mismatches.

(v) The Contractor shall ensure the full coordination between the SACS constraints and other systems such as Fire Alarm System and CCTV, or any other interfaced system.

(vi) All the SACS systems shall be studied, installed and tested in order to offer an easy maintenance and access.

(vii) All coordination, due by the Contractor, covers both hardware and software. It also covers all aspects of Shop Drawing elaboration, manufacturing, construction, testing and commissioning, to achieve
comprehensive systems in proper and efficient working order.

(viii) The final coordination on site with civil works, facades, architecture, HVAC, plumbing, electrical and any other construction aspect, remains the duty of the Contractor.

4 Detailed System Schematic Diagram

(a) Exact routing of cables, giving type and size.
(b) Exact location of for instance DC, and workstation as well as technical rooms.

5 Typical Installation Details of the System Components

(a) After installation, the Employer shall be able to perform hardware configuration changes to redefine any new mapping and modifications as desired without the services of the installer or Manufacturer.
(b) Source codes will be supplied by the installer or Manufacturer.

6 Coordination with Other Works

(a) The Contractor is to undertake the proper coordination between the works and installations of SACS and those of all other systems and interfaces that are listed above.
(b) The layout Shop Drawings is to also reveal the measures taken therein, and every fixation principle, and is to be subject to the approval of the Engineer.

7 Layout of Equipment

(a) All equipment is to be laid out as per the approved Shop Drawings.
(b) After the proper layout of all equipment is accomplished, all components are to be labeled, and marked according to an approved labeling designations and materials.

8 Installation Instructions

(a) Install equipment to comply with Manufacturer's written instructions.

9 Wiring Method

(a) Install wiring in raceway except within consoles, desks, and counters.
(b) Conceal cable and raceway except in unfinished spaces.

10 Splices, Taps, and Terminations

(a) Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.

11 Impedance and Signal Levels

(a) Match input and output impedance and signal levels at signal interfaces.
Provide matching networks where required.

12 Identification of Conductors and Cables

(a) Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.

(b) Wall-Mounting Outlets: Flush mounted.

(c) Floor-Mounting Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

13 Weatherproof Equipment

(a) Install units that are mounted outdoors, in damp locations, or where exposed to weather consistent with weatherproof rating requirements as IP 65 at least.

14 Line Matching Transformer Connections

(a) Make initial connections using tap settings indicated on Drawings.

15 Supervision

(a) Installation shall be supervised and tested by a representative of the Manufacturer of the system equipment.

(b) The work shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this work.

41.3.2 Wire and Cable

1 Principles

(a) All wiring and cable shall be installed in metal raceways or within equipment.

(b) Conductors within equipment enclosures shall be carefully wired and laced.

(c) Individual conductors shall be tagged with markers indicating the function, source, and destination of all cabling, wiring and terminals.

(d) All cables and wires shall be identified, utilizing heat-shrink, pre-printed, wire markers.

2 Number of Conductors

(a) As recommended by system Manufacturer for functions indicated.

3 Check-in and Tests

(a) After installation, and before termination, all wiring and cabling shall be checked and tested to ensure there are no grounds, opens, or shorts on any conductors or shields.
(b) A V.O.M. shall be utilized to accomplish these tests and a reading of greater than 20 Mega ohms shall be required to successfully complete the test.

4 Visual Inspection

(a) Visually inspect wire and cable for faulty insulation prior to installation.
(b) Protect cable ends at all times with acceptable end caps except during actual termination.

5 Protection

(a) Protect wire and cable from kinks.
(b) Provide grommets and strain relief material where necessary, to avoid abrasion of wire and excess tension on wire and cable.

6 Splices, Taps, and Terminations

(a) Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

7 Raceways

(a) Use communications cable tray wherever possible for low voltage cabling.
(b) Exposed raceway below 2.4 meters and in dry locations shall be rigid steel conduit.

8 Cable Trays

(a) No SACS containment including cable trays, trunking, ducts, etc. shall be loaded more than 60% of the available space. The Contractor is responsible to size the containment appropriately taking into account all systems and the type of cables to be used based on selected Manufacturer for each system.
(b) In general, SACS containment route shall follow the electrical containment route with sufficient clearance. However, any other routes followed shall be to the approval of the Engineer.

41.3.3 Grounding

1 Precaution

(a) Properly ground each piece of electronic equipment prior to applying power.
(b) Properly ground all shielded wire shields to the appropriate earth ground at the hub end only, not at the remote or device end.

2 Principles

(a) Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
(b) Clean earth for each technical room and applicable peripherals shall be provided.

41.3.4 Factory Tests

1 The Factory Acceptance Tests

(a) They are tests to be carried out in the Contractor's premises before delivery, which shall demonstrate that the system (both hardware/software and the system after integration of various sub-systems including servers, workstations, sensors, etc.) meets the technical requirements as stipulated in this Specification.

(b) The Factory Acceptance Tests shall be carried out in a hardware and software environment, which simulates the final configuration of the system.

(c) Some of the functional or performance tests, which cannot be conducted in a simulated environment, due to their nature and complications, may subject to the Engineer's approval be combined with the On-Site Tests.

(d) All travels and trips costs shall be provided by the Contractor for the Employer senior engineers and the Designer Engineer in charge to control.

2 Test Plans

(a) All tests are to be carried on according to detailed test procedures, which is submitted by the Contractor and approved by the Engineer.

(b) The tests are to cover every aspect related to the specifications of the material and their operation including, but not limited to, visual inspections, measurements, and operation.

3 Equipment Tests

(a) Equipment is to be tested for quality and operation at the factory, and test certificates and reports, certified by an official testing authority, are to be submitted to the Engineer before dispatch of equipment to site.

4 Operational Tests

(a) Operational functions available at the workstation level shall be demonstrated at factory based on a simulation.

41.3.5 On-Site Tests And Inspection

1 On-Site Assembly Verification

(a) The purpose of this phase is to check the assembly and the connection of the equipment without any power supply.

(b) Any verification can give raise to a punch list item either because of an anomaly or a none-conformity.

(c) The verifications are made sequentially for geographical area, each area giving raise to its own punch list.

(d) The punch lists are collated for each module and the phase report is only released when all the stipulations on the punch lists are cleared.
2 Test Plans
   (a) All tests are to be carried on according to a detailed test procedure, which is submitted by the Contractor and approved by the Engineer.
   (b) The tests are to cover every aspect related to the specifications of the material and their operation including, but not limited to, visual inspections, measurements, and operation.

3 On-Site Cable Tests
   (a) Cables are to be tested to ensure that no damage have occurred to them during transportation to site and/or during the course of pulling-in and laying.

4 Inspection
   (a) Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

5 Pre-Testing
   (a) Align and adjust system and perform pre-testing of all components, wiring and functions to verify compliance with specified requirements.
   (b) Correct all deficiencies by replacing malfunctioning or damaged items with new items.

6 Manufacturer's Field Services
   (a) Engage a factory-authorized service representative to inspect field-assembled components and equipment installations and perform system pre-testing, testing, adjustment and programming.
   (b) Report results in writing.

7 Procedure
   (a) Notify the Engineer not less than 30 days in advance, of proposed schedule, procedures and tests to be used in operational testing.
   (b) Conduct operational tests only with Engineer present.

8 Report
   (a) Prepare a written report of observations, inspections, tests and results, including:
      (i) A complete listing of every device and circuit.
      (ii) Date of each test and re-test, and by whom.
      (iii) Results of each test and, if failure occurred, corrective action taken prior to re-test.

9 Certification
   (a) The Contractor shall certify that all devices, circuits and total system finally tested successfully.
10 Operational Tests

(a) Schedule tests after pre-testing has been successfully completed.
(b) Perform operational system tests to verify compliance with Specifications.
(c) Test all modes of system operation including:
   (i) Functional operation of each field mounted device.
   (ii) Functional operation of each control circuit.
   (iii) Supervision functions of each initiating, indicating, monitoring, and control circuit.
(d) Integrated Tests with Other Contractors: The test procedures shall reflect the sequence of tests to be performed.
(e) Re-testing: Correct deficiencies and re-test until total system meets requirements of the Specifications and complies with applicable standards. Prepare written records of tests.
(f) Schedule testing with at least seven days advance notice.

11 Experimental Period

(a) After the on-site tests are satisfactorily completed in accordance with the technical specifications and approved procedures and before final acceptance which is leading to Provisional Taking Over; the Contractor is to assume a three month experimental period during which the system performance will be fully demonstrated under actual operation conditions.
(b) This demonstration is to confirm, to the satisfaction of the Engineer, that the system is free of remarks and is ready for provisional taking over.

41.3.6 Training

1 Trainers

(a) Engage a factory-authorized service representative to explain programming and operation of system and to train the Employer's maintenance personnel on procedures and schedules for maintaining, programming, operating, and adjusting, troubleshooting, and servicing system.

2 Training Program

(a) Scope: Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and/or maintain the equipment, systems, and facilities furnished and installed under this Contract, and to ensure a smooth transition between construction and operations activities.
(b) Language: Operators training shall be conducted in English and Arabic, however all technical training shall be in English only.
(c) Training Aids:
   (i) Training aids shall include approved operational an maintenance (O & M) manual(s) prepared by the Contractor as part of this Contract; training manuals including course outline, basic text of instructions modules, and trainee workbook; films; slides; video tape(s); charts;
models; hand-outs; catalogues; samples and other visual and written aids to complement instruction.

(ii) In addition, spare parts and other special hardware shall be provided to support "hand-on" familiarization with the equipment or systems.

(iii) Upon completion of the training program, all training aids, test equipment, and similar items provided by the Contractor for this training program shall become the property of the Employer.

(d) Training Manuals:

(i) Training manuals in English shall be provided for each training course covering both the classroom and on-the-job training phases.

(ii) The organization of the manuals shall follow the same sequence as the course’s scheduled presentation of material, providing such additional background and supplementary information, as a trainee may need to understand the O&M manuals.

(iii) There should be at least the following training manuals:
1) SACS supervisor training.
2) Electronics maintenance training.
3) CU/CR/network/workstation terminal maintenance training.

(e) Training Execution:

(i) Scope: Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training.

(ii) Contents:
1) Training course can be broken down into modules either classroom lecture or "On-the-job" training.
2) In case of lecture it is the Contractor's responsibility to provide the classroom for the duration of the course.
3) No lecture module should exceed 2 hours time.
4) "On-the-job" training can be scheduled for entire 8-hour shift.
5) At least one module for each maintenance staff should cover the SACS system and its interfaces.
6) Handouts must support each module; the collation of the handouts forms the training manual.
7) Laboratory equipment, spare parts and mock-up models may be used for theoretical orientation.
8) However, practical "hands-on" familiarization shall be provided on equipment that is either installed and operable or ready to be installed and capable of being operated. System spares of special hardware items may be used to support "hands-on" familiarization as long as said spares are returned to inventory in satisfactory condition in accordance with approved procedures.

(iii) Proficiency: At designated intervals each trainee's proficiency level shall be determined by written, oral and practical performance tests.
41.3.7 Guidelines For Documentation Transmittal

1 Content of the Transmittals

(a) The Contractor shall prepare detail drawings, design calculations, technical data sheets and samples and submit the same for review by the Engineer. The Contractor shall submit the following key elements to the Engineer for review:

(i) Detailed layout showing the marking and/or the detection equipment as required.

(ii) Manufacturers’ catalogue.

(iii) Provide all relevant testing certificates.

(iv) Inventory label for each item supplied under this Contract. Labels shall be submitted for review by the Engineer and shall be attached to each individual item for easy reference.

(b) Following documents are to be submitted to the owner prior to handing over:

(i) As-built drawings for the relevant areas.

(ii) Complete inventory list.

(iii) Three sets of Operation and Maintenance Manuals are to be provided. Such manuals shall include a full technical description with block and schematic diagrams to allow the Employer's staff to maintain the machines.

2 Drawings

(a) Note that all design development drawings, construction drawings, and As-Built drawings shall be submitted in hard copy format as well as in electronic format in the quantities specified below.

(b) Quantity of Submittals:

(i) Electronic files: 1 set.

(ii) Reproducible hardcopies: 1 set.

Prints: 3 sets.
Add the following completely new Part titled: Part 44 – Parking Control Equipments including its new clauses as follows:

44. PARKING CONTROL EQUIPMENTS

44.1 GENERAL

44.1.1 Summary

1 Drawings and general provisions of the Contract, including Terms of Reference and all contractual conditions apply to this Part.

2 All Specifications listed in this specification shall be used as functional performance-based specifications. The Contractor shall be responsible for completing and coordinating requirements necessary to design, furnish and install fully engineered and functional systems. These requirements include any site analysis, furthering of design documents, determination of quantities of equipment, verification of existing conditions and external service providers, and the like. It shall be the responsibility of the Contractor to provide any additional equipment, software, arrangements or infrastructure necessary to complete the system commissioning.

3 A turnkey Parking Control Equipments system shall be provided for the Health Centers at Al Mashaf, Umm Snim and Al Khor. The equipment shall include all hardware, software configuration and accessories required to provide fully functioning systems for integrated, segmented, car parking services to minimize inconvenience to users and redundant traffic circulation, achieved by programming system control to allow efficient use of parking spaces using re-programmable system. The system utilizes loop detectors, parking barriers, card reader, license plate recognition(LPR) subsystem and cameras, image capture processor and capacity counters and management systems components.

44.1.2 References

1 The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

2 Specific reference in Specifications to codes, rules regulations, standards, manufacturer’s instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at date of Contract unless the Document is shown dated.

3 Comply with all local codes and requirements of Authorities Having Jurisdiction (AHJ).

4 References:

(a) ASTM: American Society for Testing Materials

(b) ANSI: American National Standards Institute including:

(i) ANSI-C2 (2007);

(ii) ANSI/TIA/EIA-526-7 – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant (Method A)
(iii) ANSI/TIA/EIA-526-14A – Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant

(iv) ANSI/TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises

(v) ANSI/TIA-568-C.1 Commercial Building Telecommunications Cabling Standard

(vi) ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunication Cabling and Components Standard

(vii) ANSI/TIA-568-C.3 Optical Fiber Cabling Components Standard

(viii) ANSI/TIA/EIA-569-A

(ix) ANSI/TIA/EIA-569-A-1 to A-7

(x) ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces

(xi) ANSI/TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

(xii) ANSI/TIA/EIA Joint Standard – 607-A Commercial Building Grounding and Bonding Requirements for Telecommunications

(xiii) ANSI/TIA/EIA-758-A – Customer-Owned Outside Plant Telecommunications Cabling Standard


(xv) ANSI/TIA/EIA-854 Full Duplex Ethernet Specification for 1000Mbps Operating Over Category 6 Balanced Twisted Pair Cabling

(c) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.

(d) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.

(e) IEC 60331 Part 11& 12, Tests for Electric Cables under Fire Conditions.

(f) IEC 60332 Tests on Electric Cables under Fire Conditions.

(g) IEC 60364-1 Electrical Installations of Buildings, Fundamental Principles, Assessment of General Characteristics, Definitions.

(h) Institute of Electrical & Electronics Engineers (IEEE).

   (i) 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems

   (ii) 1100-1999 Recommended Practice for Powering and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems

   (iii) C62.41 Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

   (iv) 802.1 LAN/MAN Bridging and Management

   (v) 802.3 CSMA/CD Access Methods (Ethernet)

   (vi) 802.3ae 10 Gigabit Specification
(vii) 802.3z 1000 Base-S specification
(viii) 802.3ab 1000 Base-T specification
(ix) 802.3af/at Power over Ethernet
(x) 802.3u 100 Base-T specification
(xi) 802.1Q VLAN
(xii) 802.1P Prioritization
(xiii) 802.11 a/b/g/n CSMA/CA Access Methods (Wireless LANs)

(i) Building Industry Consulting Service International (BICSI).
(j) Federal Communications Commission (FCC) regulations and standards.
(l) Motorola R56, “Standards for Communications Sites”.
(m) CFR: Code of Federal Regulations; CFR 47 Part 15; Radio Frequency Devices
(n) IEC 603-7
(o) IETF: Internet Engineering Task Force
   (i) NTPv2 (RFC 1119), NTPv3 (RFC 1305)
   (ii) SNTP (RFC 1361), Time protocol (RFC 868)
(p) ICEA: Insulated Cable Engineers Association S-84-608-1994 Telecommunications Cable, Filled, Polyolefin Insulated Copper Conductor
(q) IBC: International Building Code 2006
(r) ISO: International Organization for Standardization including:
   (ii) ISO 9001; Quality Assurance in Design/Development, Production, Installations and Servicing;
   (iii) ISO 9003; Quality Assurance in Final Inspection and Test;
   (iv) ISO 9004; Quality Management and Quality System Elements Guidelines;
   (v) ISO/IEC JTC 1/SC 25/WG 3 N655 (Nov. 2001)
   (vi) Class D ISO/IEC 11801, 2nd Ed., Information Technology – Generic Cabling for Customer;
   (vii) Premises, 2002;
   (viii) Class E ISO/IEC 11801, 2nd Ed., Information Technology – Generic Cabling for Customer Premises;
   (x) Class FA Amendment 1 to ISO/IEC 11801, 2nd Ed.
(xi) ISO 9003 – Model for Quality Assurance in Final Inspection and Test
(xii) ISO 10012-1 – Quality Assurance Requirements for Measuring Equipment.
(xiii) ISO 18000-6C EPC Gen2 UHF RFID Tags
(s) NFPA: National Fire Protection Association
(i) NFPA 70 (2008)
(ii) NFPA 72 (2010)
(iii) NFPA 101 (2009 ed.)
(iv) NFPA 780 (2008)
(v) NFPA 5000 (2006 ed.)
(t) NEMA: National Electrical Manufacturers Association (NEMA)
(u) NESC: National Electrical Safety Code
(v) UL: Underwriters Laboratories
(i) UL 83 Thermoplastic Insulated Wire and Cables
(ii) UL 96 Lightning Protection Components
(iii) UL96A Installation Requirements for Lightning Protection Systems
(iv) UL 467 Grounding and Bonding Equipment
(v) UL 497 Protectors for Paired-Conductor Communication Circuits
(w) AIA Guidelines for Design & Construction of Health Facilities 2006
(x) Joint Commission of Hospitals - Nurse Call Requirements
(y) OSHA: Occupational Safety and Health Agency
(z) Local/National Electrical codes.
(aa) Local/National Health & Safety codes.
(bb) Local/National radio frequency regulations.
(cc) Local and national regulations and codes in effect as of date of purchase.

5 All Local Codes shall prevail. Where local Codes are silent, National Codes and Standards shall be applied. Codes, rules, regulations, and ordinances governing the work, are as fully part of the Specifications as if herein repeated or attached. If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Engineer in writing.

6 Design and Install cabling in accordance with the most recent edition of Building Industry Consulting Services International (BICSI®) publications:

(a) BICSI – Telecommunications Distribution Methods Manual (TDMM)
(b) BICSI – Information Transport Systems Installation Manual (ITSIMM)
(c) BICSI – Network Design Reference Manual
(d) BICSI – Customer-Owned Outside Plant Design Manual
7 Conflicts: Where the requirements of the specifications conflict with other documents the following shall apply:

(a) Between Plans and Specifications, between different specifications, or between different plans: Comply with the one establishing the more stringent requirement.

(b) Between referenced requirements or between industry standards: Comply with the one establishing the more stringent requirements.

(c) Between referenced requirements and Contract documents: Comply with the one establishing the more stringent requirements.

44.1.3 Scope Of Work

1 The Contractor shall provide, based on these specifications and schematic design drawings, the final design and construction documents and all equipment, material, labor and services required to construct and install the Parking Management System including, but not limited to:

(a) All design services, drawing and specifications, equipment, materials, labor and services, not specifically mentioned or shown, which may be necessary to complete the design and installation of the.

(b) Hardware including readers, servers, computers, printers, entry and exit lane equipment and loop detectors, barrier gates, capacity counters, signage, and rack accessories as specified for the system and any hardware that is specific to the Contractor system.

(c) Software application and any other software that may be required to make the system fully integrated and operational as specified including the interface with CCTV, fire alarm, access control, and other systems and any other required configuration.

(d) Installation and setup of the system hardware and software.

(e) Final connection of hardware to power, infrastructure termination and patch cords connecting system equipment to the data outlets and/or network equipment.

(f) Specifications and as-built documentation for all hardware and software components.

(g) Test plans, system testing and commissioning.

(h) System warranty as specified herein.

(i) Training, as specified herein.

(j) Maintenance and support as specified herein.

44.1.4 Qualifications

1 Project Qualifications

(a) The Contractor must currently be and have been in the business of selling, installing, and maintaining similar systems at large healthcare facilities for a minimum of five (5) years. The Contractor must have been actively
engaged in designing, installing, maintaining and operating similar systems and services as outlined in this document.

(b) The Contractor must have a minimum of three (3) sites that are actively using the same or similar solutions, and each of those solutions must be currently in operation, and have been in operation for at least the preceding twelve (12) months.

(c) The Contractor is required to submit information regarding a minimum of three (3) reference sites that are actively using the same or similar systems. The sites should be similar in terms of number of equipment, devices throughput, and network operations. This reference information shall include the contact name, address, telephone number, and date of original installation for each reference site listed. Additionally, for each reference site detail the features that make it a qualified site (e.g., final system acceptance date, number of devices, etc.).

2 Organization Qualifications

(a) The Contractor shall provide a complete description of organizations and/or firms involved including:

(i) Involvement of subcontractors or product vendors

(ii) The name of the Team Leader responsible for the project coordination, development and ongoing implementation

(iii) Detailed description of the team and organization chart noting its structure

(iv) Résumés for key personnel

(v) Specific role definition including provision for leadership, technical control, teamwork, partnering, coordination and communication

(vi) Percentage of time committed for the project by each key personnel

(vii) Mobilization plans for the different phases of the project

(viii) Listing of all current projects where there is an overlap or potential for overlap of manpower resources. For these projects provide a detailed description of the role, committed level of effort, schedule and completion date for each key individual of the proposed team.

(b) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

44.1.5 Submittals

1 Proposal Submittals:

(a) In addition to all required proposal submittals listed in the appropriate Division, the Contractor shall provide the following submittals:

(i) Design Approach: In designing the systems, it is desired to standardize hardware, operating systems, etc. in order to facilitate long-term maintenance of the systems. However, the Contractor may propose an alternative solution to any of the design requirements. These alternatives shall be clearly delineated and shall be bid as
options, in addition to the base design. Preference shall be given to vendor solutions which best integrate into the overall system design.

(ii) References: The Contractor is required to submit data sheets for same or similar implementations as specified in the “Qualifications” article of this specification.

(iii) Qualifications: The Contractor shall supply qualification data sheets for firms and persons as specified in the “Qualifications” article of this specification to demonstrate their capabilities and experience.

2 Contract Submittals:

(a) Work Plan and Schedule: The Contractor shall supply a schedule of proposed installation and implementation, including dates and milestones within 30 days of contract award. Updates shall be submitted monthly.

(b) Proposed product data sheets: The Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification Part reference for each product. Product data sheets shall be bound in a three ring binder and shall include a product index listing the model number and description of product.

(c) Samples: Submit one sample of the product components and if required a complete assembly.

(d) System Block Diagram: The Contractor shall supply a block diagram that depicts the final system design, including riser diagrams, logical flow, single line diagrams, databases, application servers, communication and distribution methods, and external interfaces.

(e) Configuration: Submit complete lists of all proposed configuration setups, business rules, process flows, and processes implemented in the system. Lists must be submitted weekly during the project and thirty (30) days prior to any formal testing.

(f) Parts Lists: The Contractor shall supply complete Systems parts lists and breakdowns that identify each component (to the lowest repairable unit) as well as ordering information for these parts shall be provided. The characteristics of each component shall also be shown, where applicable, to aid in obtaining substitute parts. Schematics and parts layout drawings to the component level are to be provided when available. The Contractor shall supply a complete list and cross-reference of all supplied documents (i.e., name, brief description, and document number).

(g) Test Plans, Test Procedures and Test Reports: Indicate testing methods, devices, and procedures. Progress payments shall depend on the successful completion of testing and documentation. Provide the test plan at least forty five (45) days prior to the scheduled start of the first test. The test plan shall detail the objectives of all tests and samples of all proposed test forms.

(h) Manufacturers’ system manuals for each system/component provided under the referenced specification Part, including:

(i) Design and Installation.

(ii) Operation/System Administration.
(iii) Maintenance and Service.
(iv) End-user.

(i) Training Plan: Indicate proposed training methods as specified in the “Training” Part of this specification.

(j) Progress Schedule – Contractor shall submit to Project Engineer estimated construction progress schedules for the Work.

(k) Compliance Matrix: Contractor shall submit a compliance matrix that summarizes compliance or non-compliance with each specification component.

3 Supply all documents necessary to enable users to operate all systems and to change feature assignments and software parameters without assistance from the Contractor. This includes a complete listing of all software parameters of the system.

4 Record Drawings: Furnish hardcopy and electronic drawings, in AutoCAD latest format, of completed work including labeling, where applicable.

44.1.6 Warranty

1 General:

(a) The Contractor shall warrant complete installation of the equipment, system, and software to be free from defects in materials and workmanship for a period of no less than twenty-four (24) months, starting with the date of Substantial Completion. As an option, the Contractor shall supply pricing for an extended Warranty of the system. This option shall be renewable on a yearly basis, and pricing shall be supplied for a minimum of five (5) years from the expiration of the initial Warranty.

2 Hardware Warranty:

(a) The Contractor shall warrant that the proposed hardware equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. This Warranty shall be in addition to any standard Warranty or service guarantee given by the Contractor to the Employer.

(b) The Warranty shall allow for replacement or repair of failed systems, equipment and components.

(c) The hardware warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(d) All hardware installed without an on-site spare shall have a twenty-four (24) hour repair/replacement Warranty from the time the Contractor is notified of the hardware failure.

3 Software Warranty:

(a) The warranty shall allow for replacement or repair of failed components. All software necessary to compile, modify, and maintain software supplied for
this specification shall be included in this warranty.

(b) The software warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(c) The warranties shall include the price of all software upgrades and computer operating system upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

44.1.7 Quality Assurance

1 General: In addition to the general requirements, the Contractor must have been in the business of selling and installing similar systems for a minimum of five (5) years. The Contractor shall have been actively engaged in installing, maintaining and operating similar systems and services as outlined in the Related Parts portion of this document. The Contractor shall include eighty (80) hours of on-site assistance (excluding travel time) to be used after the final acceptance of the system. This assistance time is in addition to Warranty services and shall be performed on an on-call basis at the Employer’s request.

(a) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

(b) The Contractor shall upgrade each software package and firmware (where applicable) used in the system to the latest version by the end of the Warranty period.

(c) The Contractor shall offer an “Optional One (1) Year Extended Warranty” package renewable for up to five (5) years to the Employer. The Employer shall inform the Contractor of the acceptance or rejection of the first year of the package at the time of final acceptance.

(i) Installation personnel shall meet manufacturer’s training and education requirements for implementation of extended warranty program.

2 NEC Compliance: Comply with NEC as applicable to construction and installation of all system components and accessories including fire rating to all cables and enclosures as applicable.

3 UL Compliance and Labeling: Provide system components, which are UL-listed and labeled.

4 Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of that type of equipment and shall be the manufacturer’s latest standard design. Items of the same classification shall be by the same manufacturer and shall be the same series and model. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.

5 All technicians providing final wire terminations, configurations, and programming on major components shall be manufacturer certified and trained on products
being installed under this project.

44.1.8 Delivery, Storage and Handling

1 Delivery: Deliver system components properly packaged in factory-fabricated type containers. Enclose an operating impact sensor in each container that is holding sensitive electronic equipment. The impact sensor shall be capable of recording a 5G rating.

2 Handling: Handle equipment and components carefully to avoid breakage, impact, denting and scoring finishes. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

3 Equipment delivered to the job site shall be opened and inspected immediately upon arriving and compared to the approved Shop Drawing submittal and checked for defects. If the equipment is not correct, the equipment shall be returned to the manufacturer immediately and a new order for the approved equipment shall be placed at no cost to the Employer.

4 Equipment and components shall be protected from the prolonged exposure, weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Employer.

44.1.9 Commissioning

1 During this phase the equipment are powered and the automation and networking are gradually integrated layer by layer.

2 The tests shall be performed by the Contractor and witnessed by the Employer’s Representative.

3 Any defects, which may become apparent during the course of these tests, shall be immediately rectified by the Contractor at his expense.

4 The Site Acceptance Test Specifications shall be prepared by the Contractor and submitted for Approval.

5 All Site Acceptance Tests shall be carried out in the presence of the Employer’s representative who shall sign off the testing documentation on satisfactory completion of the tests.

6 The results of the Site Acceptance Tests, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer’s Representative.

44.1.10 Definitions

1 Employer throughout the specifications refers to Public Works Authority (PWA).

2 Operator throughout the specifications refers to Primary Health Care Corporation (PHCC).
44.2 PRODUCTS

44.2.1 Manufacturers

1 Subject to compliance with requirements, manufactures that may be incorporated in the work, include but are not limited to, those identified in the following Section per device.

44.2.2 Parking Controls System Requirements

1 A fully integrated Parking Management system shall be provided at the Health Centers at Al Mashaf, Umm Snim, Al Khor and Al Mashaf public parking facilities. The system shall be fully integrated with all field devices including ground loops, arm barriers and card reader systems to provide a real time status of all vehicles utilizing parking garage. The system is comprised of the following components:

(a) Presence Sensor for cars and for handicapped cars
(b) Central Control Unit
(c) Zone Control Unit
(d) Parking Changeable Sign
(e) Entry Lane Equipment including readers, barrier gates, and ground loop sensors.
(f) Exit Lane Equipment including exit booths and terminals, barrier gates, and ground loop sensors.
(g) Parking Management Equipment including parking operations office equipment, servers and workstations, printers and other peripherals for operations management office.
(h) The system shall have the capability of integrating with or adding a system module for parking revenue in the future. This includes Entry Lane ticket vending equipment, Exit Lanes cashier booths and terminals, pay-on-foot stations, parking revenue control processor, and interfacing with facility financial systems.

2 Arm Riser gates provided at gate entry and exit lanes are covered in these specification.

3 The system shall utilize the Health Centers at Al Mashaf, Umm Snim, Al Khor and Al Mashaf communications infrastructure and data network equipment, to communicate between the readers and the servers.

4 The system shall be designed to meet the initial phase parking garages and lots with the ability to double the operational capacity through addition of parking equipment.

5 This section shall be used as a functional performance-based specification. The Contractor shall be responsible for completing and/or coordinating requirements necessary to deploy a fully functional Parking Management System. These requirements include any field devices design and installation, quantities of equipment, verification of parking management office requirement for complete Employer parking operation, and the like. It shall be the responsibility of the Contractor to provide any additional equipment or infrastructure necessary to
complete the system. The system final design and construction shall comply with the design intent as well as schematic design specifications listed herein and associated drawings.

44.2.3 Software

1 Software provided shall be at least 32-bit based applications at a minimum. Software shall be built around a compliant operating system as defined in this Specification. Software shall not be built for a DOS operating environment or run in a legacy shell in a Windows™ environment.

2 The software shall be designed using a modular approach, in a commonly available development environment. Software code and functionality shall be well documented in order to facilitate maintenance by personnel other than the original programmer. A single user license of the development system and any tools/utilities used during development shall be included in the proposal as a deliverable item. Custom assembly language routines are not allowed without specific permission of the Engineer.

3 The software selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of software technology, the supplied software shall be the latest released version with all manufacturer patches applied.

4 The Contractor shall deliver all required system and application software for a fully functional system. Each application shall be identified by the generic, off-the-shelf name. Software provided by the Contractor to operate the system shall be delivered in a ready-to-run form, including all necessary utility programs and documentation.

5 Software shall use industry standard components. Software shall not contain any proprietary interfaces or components. Software shall use industry standard application development software such as Java, C++, CORBA, and XML. Contractor shall state what application development software has been used, for Engineer’s review. The Engineer’s review is required for use of any Contractor recommended alternative application development software.

6 All supplied software running on servers or clients shall synchronize to a Network Time Protocol (NTP) source. The Contractor shall coordinate with other entities the exact IP address of the NTP source.

44.2.4 User Interface

1 All system applications shall have a graphical user interface to facilitate human interaction with the application and easy management of data.

2 Software modules shall have a Graphical User Interface (GUI) and use a true Microsoft® Window™ navigation interface (i.e., not legacy-based windows or X-windows or other proprietary interfaces). All web-based browsers (HTML) shall operate under a true Microsoft® Windows™ environment.

3 The system shall support both a pointing device and keyboard interface. Standard pointing device actions shall have a "hot key" equivalent. Pointing device functions without a “hot key” equivalent shall be noted.
4. The systems shall provide context sensitive, on-line help capabilities. The online help system shall contain enough information to inform the user of the nature of the current process/form/window, and provide a reference for the user to gather further information. The Contractor shall populate the on-line help messages prior to the On-site performance testing and provide a facility for maintenance and update of online help.

44.2.5 Operating System

1. Server O/S: The Contractor shall select a standardized Operating System to use across all servers. The supplier shall specify the server operating system along with any exceptions. The server operating system shall support quad core processors.

2. Client O/S: The Contractor shall select a standardized Operating System to use across all client devices. The supplier shall specify the client operating system along with any exceptions.

3. The operating system for the Contractor’s products shall meet the minimum criteria below:

   (a) 32-bit, multi-tasking, multi-threading, such as UNIX, Windows or Linux.
   (b) DOS, Windows™ 9x/Me/Millenium/NT/XP/VISTA, X-Windows, 2000 and OS/2 are not acceptable operating system solutions.
   (c) Support TCP/IP network protocol.
   (d) Latest version and service pack of the operating system at time of initiating systems testing.

44.2.6 System Architecture

1. The system shall utilize a multi-tier architecture. End devices (e.g. workstations, entry/exit lanes) shall be clients to the applications servers. Application servers in turn shall communicate with the database servers. All information shall be communicated between the server(s) and clients using the Employer Local Area Network using a dedicated VLAN.

2. Network communications shall utilize TCP/IP network communications protocol. The Contractor shall identify the network bandwidth required to support the CUPPS implementation.

3. Central Control Unit (CCU) connected to TCP/IP network to communicate with Zone Control Unit (ZCU).

4. Each ZCU collect data from presence sensors to enable CCU display this information on parking changeable sign.

5. Each barrier with lane loop sensor connected to Door Controller to be connected to TCP/IP network.

6. The system architecture shall be resilient and redundant with automatic fail-over to insure that performance and high-availability objectives are met without manual intervention. All major system components shall be designed so there is not any single point of failure causing disruptions to operations. Redundant
servers shall be located in diverse locations.

7 All devices shall be coordinated for IP addressing and VLAN segment with the network Contractor.

8 Workstations shall be mutually independent of each other (e.g., two (2) workstations at the same gate counter can access two (2) different hosts simultaneously).

9 Workstations shall be able to spool output to a peripheral device which is physically connected to another workstation or to the Network, with direct connection to the Network being preferred.

10 The systems shall facilitate integration of other applications as specified.

11 The systems shall use industry standard components. The systems shall not contain any proprietary interfaces or components and all components shall be truly common use (e.g., if the Employer wishes to change Contractor, there shall be no need to replace any equipment).

12 System components shall be independent and capable of co-existing on the system to allow for an increased level of capacity. Modular design and flexibility shall be provided for easy expansion of the system without degradation to the systems performance.

44.2.7 Security

1 Authorized users shall log into the system using a unique user name and password. Depending on assigned user access privileges, the user shall be either granted or denied access to individual applications, screens, or data.

2 The Employer’s System Administrator shall be able to add, delete, set, and change user privileges and access authorization via a GUI built into the general operations of the applications and servers. All system security parameters shall be configurable by the System Administrator.

3 The system shall have a “inactivity timeout period” such that if any workstation is determined to be inactive by having no input/output performed at that workstation for the defined timeout period, that workstation shall be automatically logged out of the system. The timeout period shall be configurable by the System Administrator. NOTE: This requirement applies only to interactive users, not to automated interfaces which are expected to be inactive during certain periods where no data is transmitted.

4 The inactivity timeout described above shall be recorded in the fault log, showing date, time, workstation identifier, and the user name logged in when the inactivity timeout occurred.

5 The system shall provide an audit trail of all transactions. The audit trail shall track on a per-user basis. The audit trail file shall indicate any changes that occurred to applications configuration, data structure, or database fields/records, and shall contain the date and time of the change, the identification of the user or the subsystem that made the change, and the details of the change.

6 The system shall provide automated tracking of the audit trail database, and alert
the System Administrator when the file has exceeded pre-determined size restrictions. The operator shall then have the ability to archive this database, along with the ability to restore it for reporting purposes. The system shall also include the option of a “rolling window”. In this case, the audit trail database shall use a rolling window with a System Administrator configurable window (i.e., after defined period of time oldest records are automatically dumped).

7 The system shall assign a specific user authorization for each user. The system shall provide the following two access levels as a minimum:

(a) Default User: This access level allows access to Parking personnel for specific host system and applications.
(b) System Administrator: This access level allows systems administration capabilities.

8 All supplied systems and computers shall be protected by virus protection software. The Contractor shall submit for review by the Engineer the exact model and configuration of the virus protection software.

44.2.8 Database

1 The proposed database(s) for all systems and subsystems shall be ORACLE™ (11.g or later) and shall include real time database mirroring and on-line archiving.

2 Database Security: The database security shall include data encryption using a strong encryption technique such as Triple DES.

3 Database Approval: The Contractor shall submit all database schema(s) for review. The Contractor shall coordinate with the Engineer, Employer and third party vendors to identify unique database requirements. The Contractor shall add needed fields as requested by the Engineer. The database(s) shall be designed such that the addition of fields and/or tables is easily accommodated. The database schema shall be provided in an electronic format (i.e. ORACLE™ DESIGNER) in addition to a hardcopy size “A0” chart showing all tables, key fields, and hierarchical relationships.

4 Database Maintenance: The database maintenance system shall be capable of maintaining configuration control (i.e., keep track of changes and compare versions of the database). Database maintenance software shall be provided to allow modification of designated database fields. Database documentation shall be provided to enable the updating or regeneration of the database tables when inputs are changed or added and as programs is modified or added.

44.2.9 Performance Requirements

1 General: The standards in the following sections apply to the entire system unless noted otherwise. Each individual system and application provided now or in the future by the Contractor shall meet these standards as a minimum:

(a) Capacity - The system shall be designed to support simultaneous operations of minimum operations of 500 transactions per hour.
(b) The system shall be capable of supporting priority orders data queuing and transmission to ensure immediate delivery of higher priority and time
sensitive messages.

(c) At peak demand, system utilization of resources shall not exceed 60% (sixty percent) of capacity.

2 System Availability: At any given time, the overall system shall be considered unavailable if any subsystem is not operational, not fully or accurately functional, or does not meet performance criteria for any given system. All systems, subsystems, software, and interfaces shall execute without degradation, at the scheduled periods and response times for the systems to be considered available. The systems shall operate as specified twenty-four (24) hours per day, seven 7 days per week. Availability of the overall system shall be at least 99.95% (4.38 hours maximum downtime per year).

3 Device Availability: A device shall be considered available only if all components are operating and fully functional. Besides scheduled downtime, as identified below, individual device availability shall be at least 99.99% (i.e., 52 minutes maximum downtime per year).

4 Scheduled Downtime: Downtime to update the computer operating system or repair a component shall be acceptable reasons for downtime, however, where components are duplicated; there shall be no interruption to system services. The following reasons are acceptable causes of downtime:

(a) If the operating systems of the servers require maintenance or updates, or if the servers require system maintenance, each server shall be brought down individually to be updated/maintained, such that at no time is more than one server down.

(b) If the operating system of the end devices requires maintenance or updates, or if the end device requires system maintenance, the end device that requires the maintenance shall be brought down during non-peak hours of operation.

(c) The Engineer may authorize maintenance/updates on the end devices during other than non-peak hours if the particular end device is non-functional without having the maintenance or updates performed.

5 Response Time: Response time criteria shall be met under maximum loading conditions.

(a) Automated portions of Entry and Exit lane transactions shall not exceed ten (10) seconds (e.g. Vehicle detection, ticket dispensing, barrier opening, etc.).

(b) Under normal conditions, the additional delay for a transaction between a workstation to a given host and return compared to a dedicated terminal shall not exceed 0.5 seconds total for ninety percent (90%) of all transactions, shall display some form of symbol showing that command has been issued, and response is pending.

(c) The time required for servers to complete a full fail-over switching shall not exceed one (1) minute.

6 The time required to restart and resynchronize the servers after a complete system failure shall not exceed fifteen (15) minutes (e.g. after an extended system outage or failure of both main and standby servers).
44.2.10 System Management

1 All devices connected to the network shall have SNMP management capability. Remote monitoring client software shall be loaded, configured and operational on all devices connected to the network.

2 System failures, including server or device failures (Presence sensor for cars and handicapped cars, Parking Changeable Sign and Zone Control unit), shall be viewable at a central control unit which connected to System Administrator's workstation). A failure shall initiate an alarm and add a failure record to the failure database table. Additionally, the system administrator shall receive a warning message on the System Administrator workstation, notifying him of the failure. The system shall also be capable of providing pager and e-mail notification. Server failure shall include any hardware or software based failure.

3 Network devices such as servers, readers or computers shall have remote administration and monitoring capabilities. This capability shall allow the specific machine to be remotely configured and to provide a status report to the management system. Data included in the reporting capabilities shall include: data pertaining to the machine's memory, storage devices, network connections, and general health of the machine.

4 In the event that a server or end device goes out of service, the central control log shall be updated. Therefore, where practical, a positive relationship (e.g., system heart beat) shall exist between all components of the systems at all time.

5 All failures of the system shall be logged at a central control point (i.e., Application Server). The failure shall initiate alarms and reports (e.g., time and date of failure event). In the event that a workstation component goes out of service, the central control log shall be updated. Therefore, where practical, a positive relationship (e.g., system heart beat) shall exist between all components of the systems at all time.

44.2.11 System Operations

1 Entry Lane Operations

(a) Upon entering a lane:

(i) For staff or service individuals, upon bringing their car to the parking column containing a card reader, the individual swipes his access card into card reader and the gate barrier goes up automatically. If the card doesn’t work, the security guard can activate push button or remote control to raise the gate.

(ii) For public visitors and ambulance individuals, upon bringing their car to the parking barrier, the security guard activates a control push-button or remote control to raise the gate.

(b) The entrance lane gate shall close automatically after the vehicle has passed over the closing detector loop. The circuitry shall be such that the entrance cycle of a vehicle shall be completed before the system will accept the entry of another vehicle through the same lane.

2 Exit Lane Operations
(a) For exiting the parking facility:
   (i) For public visitors exiting from standard exit or ambulance individuals, upon bringing their car to the parking barrier, the security guard activates a control push-button or remote control to raise the gate.
   (ii) For public visitors exiting from emergency exit, the presence of the vehicle over the detector loop shall activate the exit lane systems and the gate shall automatically open.
   (iii) For staff or service individuals, upon bringing their car to the parking column containing a card reader, the individual swipes his access card into card reader and the gate barrier goes up automatically. If the card doesn’t work, the security guard can activate push button or remote control to raise the gate.

(b) The circuitry shall be such that the exit cycle of a vehicle shall be completed before the system will accept the exit of another vehicle through the same lane.

3 Count/Control Operations

(a) The count/control system shall maintain absolute count of all vehicles entering through entry or exit lanes, passing through vehicle detectors at entry/exit points, and parked at each individual parking stall as well as violations such as vehicles passing through the lane with the gate located in the up position. Differential and total counts of legal and illegal operations shall be maintained. All entrance and exit lane parking equipment shall be monitored to identify the status of the equipment such as gates and exit verifiers. Count and occupancy information shall be utilized to update individual parking stall light indicators and dynamic signage throughout the facility to direct patrons to available parking spots.

(b) Parking Changeable Sign displays information coming from Central Control Unit (CCU), where Zone Control Unit (ZCU) knows number of cars that park through Presence detectors then ZCU collect this information from Presence detectors (each ZCU can handle up to 60 detectors) and send it back to CCU to be ready to display on parking changeable sign.

(c) Loops: Vehicle Loop Detectors shall use a coil of wire buried on both sides of the entry/exit lanes and shall be connected to the inductive loop detector. The coil of wire (detector loop) shall be installed in a rectangular slot cut into the lane surface at the time of installation. A one (1) meter x two (2) meter loop shall be utilized for the detection of standard vehicles. Larger loops shall be utilized for commercial truck lots.

4 License Plate Inventory (LPI) Operations

(a) The LPI system consisting of software and hand-held computers shall be fully integrated with the parking revenue control software. The LPI shall utilize information from License Plate Recognition System, various cameras and the manual input by staff to identify exact location of all vehicles parked within the parking garage.

5 License Plate Recognition Operations

(a) A License Plate Recognition system shall provide complete image
capturing processing, recognition, storage and retrieval. The system shall include image processing and recognition system, database and all operational cameras required as part of its operations. Security cameras are provided as part of the Security System.

6 Reports and queries shall be able to be generated to provide status. The system shall provide the following information (as a minimum):

(a) Count of vehicles
(b) Status of all equipment and field device from all locations including all dynamic signage to include:
   (i) Transponder Status
   (ii) Gate Up
   (iii) Gate Loops
   (iv) Gate Reset Loop Fail Alert
   (v) Lane Closed/Open (Red/Green Signal)
   (vi) Exception and illegal operation reports

7 Audit reports

8 The system shall run on separate servers from other Employer application system.

9 Any workstations shall have the ability to run the parking revenue management system. These workstations shall be fully functional workstations.

10 The Contractor shall provide and certify all required interfaces to make the system integrated to Employer operation systems.

44.2.12 Network Requirements

1 The system shall utilize the Employer converged network to provide services to all devices and workstations. The primary and backup servers for the system shall be located in two different main communication rooms and shall be connected to the network switches via 1000-BaseT Ethernet NICs. Clients shall be connected to the network via 10/100 Mbps Ethernet NICs (auto-negotiating). The clients shall communicate with the system applications utilizing the TCP/IP network protocol.

2 All workstations shall be connected to a dedicated VLAN using an interleaved approach to avoid total disruption of an entire row of workstations. For example, workstations shall be divided into odd positions and even positions and connected accordingly to two different network access switches.

3 All systems shall be capable of being SNMP managed, and monitored by the centralized remote management system. It is understood that the internal proprietary code of the Contractor may be monitored by a specialized program and not by SNMP. However, this must be coordinated with the requirements of the network and reviewed by the Engineer.
44.2.13 Hardware Requirements

1. All hardware requirements given are the minimum requirements. Contractor’s product shall meet or exceed these requirements. Additionally, the hardware selected shall meet the operational, functional, and performance requirements specified herein.

2. Management stations shall be industry standard PC’s each with a minimum specification or latest version at the time of purchase.

3. Due to the rapid advancement and antiquation of hardware technology, the supplied hardware shall be the “contemporary technical equivalent” of the specified hardware. For example, if a 2.4 MHz Pentium 4 processor was specified in January of 2005, then the “contemporary technical equivalent” in January of 2005 would be a 2.3 GHz Quad Core processor. “Contemporary technical equivalent” shall be based on a comparison of technology at the time of publication of the specifications to the technology at the time of ordering the equipment for each phase. Final hardware review and scheduled order date are at the sole discretion of the Engineer.

4. The system shall include all configured hardware necessary for a fully functional system. The Contractor shall supply all servers, workstations, rack accessories, converters, terminal servers, gateways, cabling, connectors, adapters, and termination equipment necessary to interconnect all system hardware and software. All hardware and materials shall be new.

5. All servers and workstation must be maintainable under warranty locally by the Employer.

6. Hardware shall be ordered as close to the actual installation date for a given phase as possible. Final hardware review and scheduled order date are at the sole discretion of the Engineer.

7. Approved Equivalent Substitution: The Contractor may propose an approved equivalent device. Requests for hardware substitution shall be submitted in writing and include the hardware cut sheet and the exact configuration being proposed.

8. Environmental Rating: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. For devices located in harsh environments such as interior uncontrolled or exterior environments, the Contractor shall provide the necessary housings or enclosures to ensure proper equipment operation and performance. The equipment shall meet the following requirements based location:

   (a) Interior controlled environment: 15 to 45 degrees C dry bulb and 20 to 90 percent relative humidity, non-condensing. Communication rooms shall be considered this type of environment.

   (b) Interior, uncontrolled environment: 0 to 60 degrees C dry bulb and 10 to 95 percent relative humidity, non-condensing. Baggage make-up and breakdown areas shall be considered this type of environment.

   (c) Exterior environments: -5 degrees to 70 degrees C dry bulb and 5 to 100
percent relative humidity, condensing.

9 The Contractor shall provide all termination components to the data outlet including patch cords for a fully operational system unless noted otherwise.

10 Active Infrastructure components (e.g., network equipment) will be supplied as part of the Employer network equipment as shown in the drawings and as noted in the specifications.

11 Hardware Structures: Contractor shall review casework to ensure proper fit of equipment, ventilation, etc. Contractor shall verify casework requirements.

12 Equipment racks: Equipment located in communications rooms shall be rack mounted in standard 19-inch (483 mm) racks. Contractor shall provide the appropriate factory or custom rack mount adapters for all equipment installed in the equipment racks, whether specifically itemized or not. Contractor shall cover unused slots using blank panels.

13 Accessories: Contractor is responsible for providing fans, shelves, drawers, special power wiring, ground connections, cables, connectors, appurtenances, and adapters of any kind necessary to accommodate the system installation, operation, testing, or maintenance.

14 Traffic Signal Lights
   (a) Red, green and Red/Green LED illuminated traffic controllers for each entry and exit lane

15 Automatic Riser Gates
   (a) General: Provide UL-approved, automatic, barrier-gate parking control system, as per approved manufacturer’s recommendation
   (b) Vehicle Access Gate shall be an all purpose semaphore type parking gate for use with wood or aluminum gate arms with different lengths up to 12 feet (3657mm) in length for small gates and up to 29.5276 feet (9000mm) for large gates. It shall be designed and configured to meet a broad range of vehicular control applications.
   (c) The drive train, the control and logic module and the cabinet shall be built to withstand heavy industrial traffic control requirements. The control and logic module shall be field programmable by the installer to meet the widest range of operating requirements, including interface with revenue systems, vehicle identification systems card readers, remote control stations, radio controls, buried detectors, etc.
   (d) The Vehicle Access Gate shall consist of a precision drive train, control and logic circuits, output shafts and gate arm clamping mechanism. These components and all other as may be required in the operational system shall be housed in a weather resistant cabinet to withstand the anticipated environmental conditions of the installation site.

16 Cabinets:
   (a) The cabinet shall be 40 inches (1016mm) tall with a 15 inch x 15 inch footprint (381mm x 381mm). A single door will provide access to the drive
mechanism and the control and logic circuits. The door will be secured to the cabinet by means of a recessed T-Handle ‘jimmy proof’ lock. The cabinet shall be weather resistant. The gate output shaft will be 36 inches (914mm) above the mounting surface and will be centered in the cabinet for either left or right hand operation.

(b) The cabinet and door shall be fabricated from a sheet aluminum, 0.125 inch thick, ASTM B209 alloy 5052, temper H32. All joints shall be welded by shielded electric arc in accordance with AWS D1.2-90 (DSC Process Specification Number 1551M).

c) Four mounting holes shall be provided for securing the cabinet to the mounting pad. Mounting holes shall be readily accessible through the cabinet door.

d) Standard cabinet color shall be white. Alternate colors shall be available from the manufacturer’s color chart.

e) Cabinet shall be finished with a thermally fused polyester/polyurethane powder coating. The cabinet shall be abrasive blasted to bright metal immediately prior to application of the powder coat. The powder coat shall have a nominal useful life of 15 years, excepting mechanical damage or abuse.

17 Limit Switches:

(a) Two heavy duty limit switches will be used to establish the full up and the full down position of the gate arm. The switches will be mounted within the cabinet and will be actuated by two adjustable cams mounted on the gate output shaft. The limit switches will be wired into a single harness which will plug into the control and logic circuit module.

18 Gate Output Shaft / Gate Arm Clamp:

(a) The gate output shaft shall be rotated by securely welded crank arm. A connecting link between the crank on the gate output shaft and the crank arm on the gear reducer will provide for lineal speed reduction/output torque increase. The gate arm clamp will be securely pinned to the gate output shaft. The gate arm clamp will be capable of handling wooden arm gate arms up to 6.0 inches wide and 0.75 inches thick (152mm x 19mm) and aluminum arms up to 6.0 x 1.5 inches (152mm x 38mm).

(b) The clamp will incorporate a gate saver feature to minimize damage to the Access Gate should a vehicle atrike the arm.

(c) Both the gate arm shaft and the gate arm clamp will be suitably plated to inhibit rust and corrosion.

(d) Gate arm length shall be in line with access lane width.

19 Control And Logic Circuit Module:

(a) The control and logic circuit module shall be mounted with the cabinet. The module will be divided into two sections. One section will contain the logic circuit and motor control components. The other section of the module shall be cabled to the motor and limit switches through two industrial type connector sockets.
(b) The control switches for operating, servicing and setting the gate will be mounted on the outside of the control and logic circuit module. These will include an on/off main power switch, a selector switch for manual/automatic Access Gate operation and an on/off/automatic thermostat switch for when the optional cabinet space heater is required.

(c) A 15 amp duplex convenience receptacle shall be provided on the control module (USA 115 VAC versions only).

(d) Knockouts on the control module shall be provided to accommodate vehicle detector harnesses or other accessories.

44.2.14 Expansion And Spares

1 The Contractor shall clearly state limitations of the proposed system in terms of adding additional capacity, servers, and interfaces. The Contractor shall clearly state the limitations of the expansion of the base system proposed in terms of additional display devices, as it relates to the ability of the Host Computer to service those additional devices, with no changes to network design. Particular attention should be given to the number of workstations before which additional processing power, memory, and/or disk storage would be required for the Host Computer.

2 At the time of final system acceptance, all hardware shall have a minimum of fifty percent (50%) reserve capacity, with the capability to double the capacity with no change to the system design.

3 The system shall be designed such that expanding or adding new devices shall not have a negative impact on the system.

4 The Contractor shall provide five percent (5%) spare equipment for all field devices (e.g. workstations, readers, etc.).

44.3 EXECUTION

44.3.1 Examination

1 The Employer assumes no responsibility or liability for transportation from country of origin, storage fees, drayage, import taxes, duty taxes, or other costs associated with the delivery and storage of system components.

2 Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the Employer.

3 Contractor shall store products in accordance with manufacturer's instructions, within Contractor's staging area and with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

4 Contractor shall provide coverings to protect products from damage from traffic and construction operations, remove when no longer needed.

5 Contractor shall ensure that all work performed under these Specifications is in accordance with the requirements and standards defined and referenced in these Specifications. Any work performed in deviation of these Specifications, any of the referenced material, or any applicable standards or requirements, shall
immediately be corrected by the Contractor without additional charges, regardless of the stage of completion. The Contractor shall record all inspection observations. As a minimum, the record shall include the name(s) of personnel conducting the inspection, a brief description of the inspection and the observations. These records shall be available for the Engineer to review at any time. Also, these records shall be delivered to the Engineer before final acceptance.

6 Installation Inspections: Installation inspections shall be undertaken through the performance of pre-installation, in-progress, and final inspections as follows:

(a) Pre-Installation Inspection: The Contractor shall make an inspection of all equipment and material to be used prior to installation. All items shall be verified for compliance with the requirements of these Specifications and all other applicable standards. All equipment, cable, and associated hardware identified for installation shall be inspected for damage and completeness utilizing standard practices to determine integrity and acceptability.

(b) In-Progress Inspection: At the Engineer’s discretion, the Contractor shall perform in-progress inspections that shall include visual inspections of equipment, wiring practices, cabling, placement of equipment, marking of cables and adherence to safety procedures. In addition, the Employer, or his representative, may conduct additional inspections any time.

(c) Final Inspection: The Contractor shall conduct a final inspection that encompasses all portions of the installation. This inspection shall be performed to ensure that all aspects of the installation have been performed in accordance with these Specifications, standard industry practices and the publications referenced herein. All non-compliance items shall be noted by the Contractor during this inspection. The Engineer shall witness this inspection.

(d) Corrective Action and Verification Inspection: The Contractor shall perform all corrective actions to ensure that all non-compliance items identified during the final inspection have been corrected.

44.3.2 Installation

1 Standards: All installation activities shall be performed in a neat and professional manner in accordance with all applicable local and national codes. Additionally, the Contractor and all subsequent Sub-Contractors employed to satisfy the requirements of these specifications shall obtain, or satisfy, the following prior to installation:

(a) All licenses and permits

(b) All insurance and bonding as required

(c) All other standards or requirements specified in this document

2 Contractor shall install and inspect all hardware required in this specification in accordance with the manufacturer’s installation instructions.

3 Contractor shall adhere to the following during installation of the system:

(a) Underwriter’s Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the
National Electric Code for customer premise installations.

(b) Fire resistance requirements specified by Underwriter's Laboratories in UL 1459, 2nd edition.

4 Where undefined by codes and standards, Contractor shall apply a safety factor of at least two (2) times the rated load to all fastenings and supports of system components.

5 Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

6 Rack Mounted Equipment:

(a) As a general practice, Contractor shall run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the rear.

(b) The Contractor shall run other cables on the right side of an equipment rack, as viewed from the rear.

(c) For equipment mounted in drawers or on slides, provide the rack accessories as well as interconnecting cables with a service loop of not less than three feet and ensure that the cable is long enough to allow full extension of drawer or slide.

7 Contractor shall install all custom and packaged software in the development and production environments.

8 Contractor shall provide a migration plan for all new and updated software to be migrated from within the development environment to the production environment.

9 Final hardware selected and installation of hardware shall be submitted for review by the Engineer. Additionally, the Contractor shall review the cabinets and equipment room to ensure ventilation requirements are met or recommend modifications.

10 Contractor shall install and configure all software required in this Specification in accordance with the software manufacturer's installation instructions. Apply the latest patches and security updates. Register the application with the manufacturer under the Employer's name.

11 The contractor shall facilitate, configure, document and test all network connections required by other systems or other facilities not in contract that require access to the network specified herein.

12 Contractor shall place materials only in those locations that have been previously authorized. Any other locations shall be authorized, in writing, by the Engineer.

13 Contractor shall provide all tools, applications and test equipment required to install, verify, and test the installation and to determine that it meets the specifications. The Contractor shall furnish all necessary materials required to implement and to achieve the required work performance.
44.3.3 Documentation

1 This Part requires complete documentation of all systems for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts. All documentation, as described herein shall be submitted to the Engineer for approval sixty (60) days prior to final submission.

2 Scope: The Contractor shall provide the Employer with Operation and Maintenance Manuals and other documentation on all installed systems. These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.

3 The maintenance manual requirement of this Part is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing, and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.

4 Maintenance Manuals, Manufacturer’s Literature: Provide manufacturer’s standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.

5 Drawing Books: All Drawings developed specifically for this Project shall be reduced to half-size, folded and bound with hard plastic covers. The half-size Drawings provided shall be easily readable after printing, even if this requires breaking large Drawings into several parts. Text shall be no smaller than 2 mm. The drawing book documents shall be produced with current version of AutoCAD and the electronic files shall be provided to the Employer at the completion of the Project on DVD/CD-ROM. Provide component identification and cross reference on the Drawings to allow the maintenance department to understand the function of each item (the block diagram), find the room where the device is mounted (Contract Document plans), find its location in a rack (Arrangement Drawings), find how it is wired (wiring diagrams), and its detailed Specifications (vendor data sheets), and how to repair it (spare part lists). Include the following drawings as a minimum:

(a) System Block Diagram: This drawings shall depict the final LAN overview, including equipment types, location, IP addresses and any special information

(b) System Riser Diagram(s): These drawings shall show all LAN components, wire numbers, color codes, pin numbers, component locations and connections, depicting the “as-built”, final configuration

(c) Rack Elevation and Wiring Diagram(s): The elevation diagrams shall depict
the front views of the equipment racks identifying all equipment installed within. Complete wiring diagrams of the racks shall also be included

(d) Floor plans of the communications rooms showing the location of all equipment effected as a part of this contract within the communications rooms

(e) Elevation drawings of all wall mounted equipment showing the location of each component on the wall. Components on the walls shall be identified as in the functional block diagrams

(f) Wiring Diagrams: Provide wiring diagrams showing all field installed interconnecting wiring. Wire identification on the diagrams shall agree with the wire markers installed on the equipment

(g) System Administrator Documentation: The Contractor shall supply three (3) hardcopies of administrator documentation and three (3) copies of the documentation in PDF format on CD-ROM that detail the operation of the system. This documentation shall provide complete information on the configuration, business rules, operation, maintenance, and trouble-shooting of the system

6 Warranty: The Contractor shall supply all warranties as required in the “Warranty” article of this specification.

44.3.4 General Testing Requirements

1 Phases of Testing:

(a) Factory Acceptance Testing

(b) Integration Testing

(c) Endurance Testing

2 Project Testing: The system installation shall not be considered complete until On-Site Endurance Testing are completed. The purpose is to test the complete system and demonstrate that all specified features and performance criteria are met. All requirements of the specification shall be tested, including:

(a) Functionality, including reporting and response

(b) System capacity

(c) Hardware and software interaction

(d) Failure Recovery

(e) Report generation

3 Test Plan/Procedure: Contractor shall provide six (6) copies of the proposed test plan/procedures for each testing phase for the review of the Engineer. The test plan for each phase of testing shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The submission of Test Plans shall adhere to the following:

(a) A draft test plan shall be presented to the Engineer at least forty-five (45) days prior to the scheduled start of each test
(b) A workshop for reviewing comments shall be conducted with the Engineer at least thirty (30) days prior to the scheduled start of each test

(c) A final test plan shall be submitted to the Engineer at least fourteen (14) days prior to the scheduled start of each test

4 Test plans shall contain at a minimum:

(a) Functional procedures including use of any test or sample data

(b) Test equipment is to be identified by manufacturer and model including LAN analyzers and packet sniffers

(c) Interconnection of test equipment and steps of operation shall be defined

(d) Expected results required to comply with specifications

(e) Traceability matrix referencing Specification requirements with specific test procedures

(f) Record of test results with witness initials or signature and date performed

(g) Pass or fail evaluation with comments

5 The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.

6 All Test plans must be reviewed by the Engineer. To successfully complete a test, the test document must be signed and dated by both the Contractor and the Engineer.

7 The Engineer will review, witness and validate the execution of all formal test procedures prepared by the Contractor and deliverable under the contract to assure the tests cover all requirements and that there is a conformity between the conducted test, the test results and Specification requirements.

8 Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.

9 The Contractor shall provide the Employer or Employer representative the opportunity(s) to participate in any or all of tests.

10 Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Six (6) copies of the test report shall be submitted to the Employer representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:

(a) Commentary on test results

(b) A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution

(c) Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test
Signatures of persons who performed and witnessed the test

11 Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to Employer. The problems identified in each phase shall be corrected and the percentage of the entire system re-tested determined by the Engineer before any subsequent testing phase is performed.

44.3.5 Factory Acceptance Testing

1 The purpose of this test is to validate that the individual systems components function as standalone equipment and all specified features are met.

2 The Contractor shall ensure that development of the system is complete, required approvals of submittals have been obtained, and sufficient equipment has been procured to completely demonstrate and test the system.

3 Factory Acceptance testing shall be completed at an Employer authorized test site.

4 Test Setup Equipment: Equipment shall be the actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting pre-delivery test:

(a) Equipment associated with the system
(b) Devices associated with system
(c) Software associated with system
(d) Administrative tools and equipment
(e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

5 Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer authorized personnel.

6 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

7 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

8 Reporting:

(a) Record all test procedures and results
(b) Submit report in accordance with reporting requirements in General Testing Requirements Section.

44.3.6 Integration Testing

1 The purpose of this test is to validate integration between the system and other interfaced subsystems or systems and to demonstrate that all specified features are met. All requirements of the Parking Control Equipments system integration shall be tested including connectivity, interaction, interface, format, and data flow.
Integration testing shall be completed at the systems integration laboratory or other authorized location on-site at the campus. Interfaces may be tested using simulated data to/from other systems.

Test Setup Equipment: Equipment shall be actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting the test:

(a) Equipment associated with the system  
(b) Devices associated with system  
(c) Software associated with system  
(d) Administrative tools and equipment  
(e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer personnel.

Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

Reporting:

(a) Record all test procedures and results  
(b) Submit report in accordance with reporting requirements in General Testing Requirements Part

44.3.7 Endurance Testing

The purpose of this test is to validate that the fully integrated system meets the Endurance and High Availability requirements.

Integration testing shall be completed on-site at the Health Centers at Al Wakra, Al Mashaf, Umm Snim, Al Khor and Al Mashaf. All interfaces shall be tested using actual interfaces to other systems (i.e. no stubs or dummy data.)

Requirements:

(a) Provide personnel to monitor system operations 24 hours per day, including weekends and holidays during Endurance Testing  
(b) Start test after:  
   (i) Successful completion of Integration Testing  
   (ii) Training as specified has been completed  
   (iii) Correction of deficiencies has been completed  
   (iv) Receipt of written start notification from the Engineer
(c) Monitor all systems during Endurance Testing. Coordinate monitoring with the Engineer

(d) Recording: Record data on forms so as to provide a continuous log of systems performance. Include:

(i) Date and time for all entries

(ii) Name of individual making entry

(iii) Environmental conditions

(iv) Activities in process

(v) Description of all alarms, responses, corrective actions, and causes of alarms. Classify as to type of alarm

(vi) Description of all equipment failures, including software errors

(vii) Description of all maintenance and adjustment operations performed on system

(viii) Daily and weekly tabulations

(ix) Daily entries of performance data shall be reviewed by the Engineer

(e) Employer may terminate testing at any time when the system fails to perform as specified. Upon termination of testing the Contractor shall commence an assessment period as described in Stage II

4 Testing

(a) Stage I - Initial Phase Testing:

(i) Time: 24 hours per day for 30 consecutive calendar days

(ii) Make no repairs during this stage unless authorized in writing by the Engineer

(iii) If system experiences no failures, proceed to Stage III - Final Testing

(b) Stage II - Initial Phase Assessment:

(i) After conclusion of Stage I, or terminating of testing, identify all failures, determine causes, and repair. Submit report explaining: Nature of each failure, corrective action taken, results of tests performed to verify corrective action as being successful, and recommended point for resumption of testing

(ii) After submission of report, schedule review meeting at job site. Schedule date and time with the Engineer

(iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests

(iv) Based on report and review meeting, the Engineer will direct Contractor to repeat Stage I, restart Stage I, or proceed to Stage III - Final Testing

(c) Stage III - Final Phase Testing:

(i) Time: 24 hours per day for 15 consecutive calendar days

(ii) Make no repairs during this stage unless authorized in writing by the Engineer
(d) Stage IV - Final Phase Assessment:
   (i) After conclusion of Stage III or termination of testing, identify all failures, determine causes, and repair. Submit explaining the nature of each failure, corrective action taken, results of tests performed, and recommended point for resumption of testing.
   (ii) After submission of report schedule review meeting at job site. Schedule date and time with the Engineer.
   (iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests.
   (iv) Based on report and review meeting, the Engineer will review Endurance Test or direct Contractor to repeat all or part of Stages III and IV.

5 Adjustment, Correction, and Maintenance

   (a) Adjustment and Correction: Make adjustments and corrections to system only after obtaining written approval of the Engineer.
   (b) Maintenance: Perform required maintenance on systems including provision of replacement parts.

6 Final Inspection and Acceptance

   (a) After Endurance Testing is complete, review tabulated records with the Engineer.
   (b) Contractor will not be responsible for failures caused by:
      (i) Outage of main power in excess of backup power capability provided that automatic initiation of all backup sources was accomplished and automatic shutdowns and restarts of systems performed as specified.
      (ii) Failure of any Employer furnished power, communications, and control circuits provided failure not due to Contractor furnished equipment, installation, or software.
      (iii) Failure of existing Employer equipment provided failure not due to Contractor furnished equipment, installation, or software.
   (c) When performance of system does not fall within the above parameters, determine cause of deficiencies, correct, and retest.
   (d) When requested by the Employer, extend monitoring period for a time as designated by the Employer.
   (e) Period shall not exceed 60 days exclusive of retesting periods caused by termination of Stages I or III and assessment period of Stages II and IV.
   (f) Submit final report of Endurance Testing containing all recorded data.

44.3.8 Maintenance And Support

1 General

   (a) The Contractor shall provide maintenance and support of all components associated with this system at no additional charge during the warranty period. This extends to systems requiring vendor pre-purchased maintenance agreements.
(b) The Contractor shall supply a list of special tools, test equipment, and outside inventory required for this Project. The Contractor may recommend specific items to facilitate long-term support of the system as an option to the Employer.

(c) All lead technicians performing installation and maintenance shall have a minimum of two (2) years experience on the proposed system and be manufacturer certified on all hardware/software applications. All maintenance technicians shall be provisioned to attend a one (1) week manufacturer training class each year. Pre-assigned backup technicians shall be available to backfill for onsite technicians who are on vacation, in training or who are out sick.

(d) The Contractor shall provide twenty-four (24) hours/seven (7) days a week telephone support as a minimum maintenance and support agreement. Additionally, the Contractor shall specify a maximum amount of time to get the system up and operational in the event of a system failure. This time period shall be subject to Engineer’s approval.

2 Hardware and Software Support

(a) Hardware and Software support shall be supplied by the Contractor directly or by a Sub-Contractor reviewed by the Employer. Support shall cover all equipment and systems referenced in this Specification.

(b) The Contractor shall assume full responsibility for the performance of all equipment supplied by the Employer, provided that such equipment meets the specifications set forth by the Contractor.

(c) All software shall be delivered with an installable backup.

3 Pricing after Warranty Period: Cost of maintenance and support on a yearly basis after the Warranty period has expired, shall be included as an option to be exercised by the Employer or his designated representative. Contractor shall clearly state in the bid the annual cost and availability of the following services that the Employer may wish to use or to continue after the initial Warranty period has expired (Costs shall be given for a three (3) years with additional two (2) years to be renewed on an annual basis):

(a) Costs of maintenance of the equipment and software

(b) Cost of software and firmware upgrades

(c) Telephone consultation support

(d) Technicians on-site (including travel, meals and lodging) to repair or replace malfunctioning equipment or software, if not covered in the maintenance costs above.

(e) Programming on message text, animation sequences, and the like for Employer use and operation.

4 Definitions

(a) Preventive and Routine Maintenance: Preventive and routine maintenance services shall be provided in accordance with the provisions of the maintenance manual for each component. Preventative maintenance services shall include inspection, test, necessary adjustment, lubrication,
parts cleaning, and upgrades. Routine maintenance services shall include scheduled overhauls as recommended by the equipment manufacturer.

(b) Emergency Failure: A system failure is considered an emergency if any of the key components are inoperative to the extent the system cannot function in a normal manner. Emergency services shall include inspections and necessary tests to determine the causes of equipment or software malfunction or failure. The emergency services shall include furnishing and installing components, parts, or software changes required to replace malfunctioning system elements. The Contractor shall provide telephone support twenty-four (24) hours a day, seven (7) days a week. The Contractor shall provide support on-site within eight (8) hours of request.

(c) Support: Support shall be supplied by the Contractor directly or by a sub-Contractor reviewed by the Employer. Support shall cover all equipment referenced in this specification.

44.3.9 Cleaning

1. Upon completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

44.3.10 Training

1. The User Training shall include on-the-job-training of at least two (2) weeks. The training shall be conducted on site at the Health Centers at Al Wakra, Al Mashaf, Umm Snim, Al Khor and Al Mashaf or other campus location provided by the Employer.

2. The System Administrators Training shall include on-the-job training. Six (6) weeks of on-the-job training shall be provided. This training shall be conducted on site at the Health Centers at Al Wakra, Al Mashaf, Umm Snim, Al Khor and Al Mashaf or other campus location provided by the Employer.

3. The Contractor shall provide the Employer specified trainees with detailed As-built information by the Contractor Lead Engineer. The training shall provide the system Administrators with a working knowledge of the system design and layout, and shall provide troubleshooting methods and techniques. In addition, the training shall cover testing, maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.

4. Course materials shall be delivered to the Employer. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the Employer. The Contractor shall supply a videotape of each training course.

5. All training shall be completed a minimum of two (2) weeks prior to the system becoming operational and utilized by the Employer. Training schedule subject to the Employer’s review.

44.3.11 Acceptance

1. The Contractor shall not apply power to the system until after:

   (a) System and components have been installed and inspected in accordance
with the manufacturer's installation instructions

(b) A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections

(c) System wiring has been tested and verified as correctly connected as indicated

(d) All system grounding and transient protection systems have been verified as properly installed and connected, as indicated

(e) Power supplies to be connected to the system and equipment have been verified as the correct voltage, phasing, and frequency as indicated

2 Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3 Acceptance will be withheld until the following have been completed successfully:

(a) Acceptance of all submittals

(b) Successful testing and delivery of approved test results

(c) Completed Training as per the specifications as well as successful demonstration of the operation of the entire system

(d) Final cleanup of the system and work areas
   Delivery of all documentation including accepted As-built documentation.
Add the following completely new Part titled: Part 48 – Master Clock System including its new clauses as follows:

48. MASTER CLOCK SYSTEM

48.1 GENERAL

48.1.1 Summary

1 Drawings and general provisions of the Contract, including Terms of Reference and all contractual conditions apply to this Part.

2 All Specifications listed in this specification shall be used as functional performance-based specifications. The Contractor shall be responsible for completing and coordinating requirements necessary to design, furnish and install fully engineered and functional systems. These requirements include any site analysis, furthering of design documents, determination of quantities of equipment, verification of existing conditions and external service providers, and the like. It shall be the responsibility of the Contractor to provide any additional equipment, software, arrangements or infrastructure necessary to complete the system commissioning.

3 The Master Clock includes the following types of devices:

   (a) Master Clock Time Server: Stratum 1 time server to provide accurate time information to network devices.

   (b) Slave Clocks synchronized to the Master Clock Time Server.

4 The MC includes software and hardware components such as Master Clock time server, NTP client software, clocks and interfaces to data Network and other electronic systems.

5 The MC shall utilize the communications infrastructure and data Network equipment to provide accurate timing information to other systems.

6 The MC system shall meet ANSI/T1.101 Primary Reference Source.

7 The MC system final design and construction shall comply with the design intent as well as specifications listed herein and associated drawings.

48.1.2 References

1 The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

2 Specific reference in Specifications to codes, rules regulations, standards, manufacturer’s instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at date of Contract unless the Document is shown dated.

3 Comply with all local codes and requirements of Authorities Having Jurisdiction (AHJ).
4 References:

(a) ASTM: American Society for Testing Materials
(b) ANSI: American National Standards Institute – All EIA relevant standards
(c) Institute of Electrical & Electronics Engineers (IEEE).
(d) Building Industry Consulting Service International (BICSI).
(e) Federal Communications Commission (FCC) regulations and standards.
(f) IEC 603-7
(g) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.
(h) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.
(i) IEC 60331 Part 11 & 12, Tests for Electric Cables under Fire Conditions.
(j) IEC 60332 Tests on Electric Cables under Fire Conditions.
(k) IEC 60364-1 Electrical Installations of Buildings, Fundamental Principles, Assessment of General Characteristics, Definitions.
(l) ICEA: Insulated Cable Engineers AssociationS-84-608-1994 Telecommunications Cable, Filled, Polyolefin Insulated Copper Conductor
(m) IBC: International Building Code 2006
(n) ISO: International Organization for Standardization
(o) NFPA: National Fire Protection Association
   (i) NFPA 70 (2008)
   (ii) NFPA 72 (2010)
   (iii) NFPA 101 (2009 ed.)
   (iv) NFPA 780 (2008)
   (v) NFPA 5000 (2006 ed.)
(p) NEMA: National Electrical Manufacturers Association (NEMA)
(q) NESC: National Electrical Safety Code
(r) UL: Underwriters Laboratories
   (i) UL 83 Thermoplastic Insulated Wire and Cables
   (ii) UL 96 Lightning Protection Components
   (iii) UL96A Installation Requirements for Lightning Protection Systems
   (iv) UL 467 Grounding and Bonding Equipment
   (v) UL 497 Protectors for Paired-Conductor Communication Circuits
(s) OSHA: Occupational Safety and Health Agency
(t) Local/National Electrical codes.
(u) Local/National Health & Safety codes.
(v) Local and national regulations and codes in effect as of date of purchase.

5 All Local Codes shall prevail. Where local Codes are silent, National Codes and Standards shall be applied. Codes, rules, regulations, and ordinances governing the work, are as fully part of the Specifications as if herein repeated or attached. If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Engineer in writing.

6 Design and Install cabling in accordance with the most recent edition of Building Industry Consulting Services International (BICSI®) publications.

7 Conflicts: Where the requirements of the specifications conflict with other documents the following shall apply:

(a) Between Plans and Specifications, between different specifications, or between different plans: Comply with the one establishing the more stringent requirement.

(b) Between referenced requirements or between industry standards: Comply with the one establishing the more stringent requirements.

(c) Between referenced requirements and Contract documents: Comply with the one establishing the more stringent requirements.

48.1.3 Related Parts

1 A. Part 14 - Structured Cabling Network

48.1.4 Scope Of Work

1 The Contractor shall provide, based on these specifications and schematic design drawings, the final design and construction documents and all equipment, material, labor and services required to construct and install the MC including, but not limited to:

(a) All design services, drawing and specifications, equipment, materials, labor and services, not specifically mentioned or shown, which may be necessary to complete the design and installation of the MC.

(b) Hardware including Time Server as specified for the system and any hardware that is specific to the manufacturer submitted system.

(c) Software application and any other software that may be required to make the system fully operational as specified including the provision of IP addresses.

(d) Installation and setup of the system hardware and software.

(e) Providing multiple product samples of Analog (Power over Ethernet NTP enabled) clocks for the Employer to select from as part of the Master clock System.

(f) Final connection of hardware to power, infrastructure termination and patch cords connecting system equipment to the data outlets and other network communication equipment.

(g) Specifications and As-built documentation for all MC hardware and software components.
(h) Test plans, system testing and commissioning.
(i) System warranty as specified herein.
(j) Training as specified herein.
(k) Maintenance and support as specified herein.

2 MC shall be provided for the facilities indicated in the Systems Building Matrix.

3 Work not included: the following work is not specified by this section:

(a) Designing or providing physical pathways such as conduits, sleeves, innerducts and cable trays.
(b) Designing or providing electrical system and services to field devices, servers and communications rooms, including 220V wiring and outlets.
(c) Designing or providing heating, ventilation or air conditioning (HVAC) systems to meet indoor environmental requirements with the exception of outdoor or harsh environment devices, which shall be provided with special ventilation and outdoor-rated enclosures.
(d) Designing or providing cabling infrastructure including fiber, copper, patch panels or communication room racks and cabinets with the exception of patch cabling.
(e) Designing or providing Data Network equipment such as data switches, routers or firewalls.

48.1.5 Qualifications

1 Project Qualifications

(a) The Contractor must currently be and have been in the business of selling, installing, and maintaining similar systems at large healthcare facilities for a minimum of five (5) years. The Contractor must have been actively engaged in designing, installing, maintaining and operating similar systems and services as outlined in this document.

(b) The Contractor must have a minimum of three (3) sites that are actively using the same or similar solutions, and each of those solutions must be currently in operation, and have been in operation for at least the preceding twelve (12) months.

(c) The Contractor is required to submit information regarding a minimum of three (3) reference sites that are actively using the same or similar systems. The sites should be similar in terms of number of equipment, devices throughput, and network operations. This reference information shall include the contact name, address, telephone number, and date of original installation for each reference site listed. Additionally, for each reference site detail the features that make it a qualified site (e.g., final system acceptance date, number of devices, etc.).

2 A same or similar solution shall satisfy all the following conditions:

(a) Utilizing GPS-based stratum 1 time source
(b) Utilizing Network Timing Protocol for TCP/IP time synchronization
3 Organization Qualifications

(a) The Contractor shall provide a complete description of organizations and/or firms involved including:

(i) Involvement of subcontractors or product vendors

(ii) The name of the Team Leader responsible for the project coordination, development and ongoing Implementation

(iii) Detailed description of the team and organization chart noting its structure

(iv) Résumés for key personnel

(v) Specific role definition including provision for leadership, technical control, teamwork, partnering, coordination and communication

(vi) Percentage of time committed for the project by each key personnel

(vii) Mobilization plans for the different phases of the project

(viii) Listing of all current projects where there is an overlap or potential for overlap of manpower resources. For these projects provide a detailed description of the role, committed level of effort, schedule and completion date for each key individual of the proposed team.

(b) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

48.1.6 Submittals

1 Proposal Submittals:

(a) In addition to all required proposal submittals listed in the appropriate Division, the Contractor shall provide the following submittals:

(i) Design Approach: In designing the systems, it is desired to standardize hardware, operating systems, etc. in order to facilitate long-term maintenance of the systems. However, the Contractor may propose an alternative solution to any of the design requirements. These alternatives shall be clearly delineated and shall be bid as options, in addition to the base design. Preference shall be given to vendor solutions which best integrate into the overall system design.

(ii) References: The Contractor is required to submit data sheets for same or similar implementations as specified in the “Qualifications” article of this specification.

(iii) Qualifications: The Contractor shall supply qualification data sheets for firms and persons as specified in the “Qualifications” article of this specification to demonstrate their capabilities and experience.

2 Contract Submittals:

(a) Work Plan and Schedule: The Contractor shall supply a schedule of proposed installation and implementation, including dates and milestones within 30 days of contract award. Updates shall be submitted monthly.

(b) Proposed product data sheets: The Contractor shall submit catalogue cut-
sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification Part reference for each product. Product data sheets shall be bound in a three ring binder and shall include a product index listing the model number and description of product.

(c) Samples: Submit one sample of the product components and if required a complete assembly.

(d) System Block Diagram: The Contractor shall supply a block diagram that depicts the final system design, including riser diagrams, logical flow, single line diagrams, databases, application servers, communication and distribution methods, and external interfaces.

(e) Configuration: Submit complete lists of all proposed configuration setups, business rules, process flows, and processes implemented in the system. Lists must be submitted weekly during the project and thirty (30) days prior to any formal testing.

(f) Parts Lists: The Contractor shall supply complete Systems parts lists and breakdowns that identify each component (to the lowest repairable unit) as well as ordering information for these parts shall be provided. The characteristics of each component shall also be shown, where applicable, to aid in obtaining substitute parts. Schematics and parts layout drawings to the component level are to be provided when available. The Contractor shall supply a complete list and cross-reference of all supplied documents (i.e., name, brief description, and document number).

(g) Test Plans, Test Procedures and Test Reports: Indicate testing methods, devices, and procedures. Progress payments shall depend on the successful completion of testing and documentation. Provide the test plan at least forty five (45) days prior to the scheduled start of the first test. The test plan shall detail the objectives of all tests and samples of all proposed test forms.

(h) Manufacturers’ system manuals for each system/component provided under the referenced specification Part, including:

   (i) Design and Installation.
   (ii) Operation/System Administration.
   (iii) Maintenance and Service.
   (iv) End-user.

(i) Training Plan: Indicate proposed training methods as specified in the “Training” Part of this specification.

(j) Progress Schedule – Contractor shall submit to Project Engineer estimated construction progress schedules for the Work.

(k) Compliance Matrix: Contractor shall submit a compliance matrix that summarizes compliance or non-compliance with each specification component.

3 Supply all documents necessary to enable users to operate all systems and to change feature assignments and software parameters without assistance from the Contractor. This includes a complete listing of all software parameters of the system.
48.1.7 Warranty

1 General:

(a) The Contractor shall warrant complete installation of the equipment, system, and software to be free from defects in materials and workmanship for a period of no less than twenty-four (24) months, starting with the date of Substantial Completion. As an option, the Contractor shall supply pricing for an extended Warranty of the system. This option shall be renewable on a yearly basis, and pricing shall be supplied for a minimum of five (5) years from the expiration of the initial Warranty.

2 Hardware Warranty:

(a) The Contractor shall warrant that the proposed hardware equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. This Warranty shall be in addition to any standard Warranty or service guarantee given by the Contractor to the Employer.

(b) The Warranty shall allow for replacement or repair of failed systems, equipment and components.

(c) The hardware warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(d) All hardware installed without an on-site spare shall have a twenty-four (24) hour repair/replacement Warranty from the time the Contractor is notified of the hardware failure.

3 Software Warranty:

(a) The warranty shall allow for replacement or repair of failed components. All software necessary to compile, modify, and maintain software supplied for this specification shall be included in this warranty.

(b) The software warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(c) The warranties shall include the price of all software upgrades and computer operating system upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

48.1.8 Quality Assurance

1 General: In addition to the general requirements, the Contractor must have been in the business of selling and installing similar systems for a minimum of five (5) years. The Contractor shall have been actively engaged in installing, maintaining and operating similar systems and services as outlined in the Related Parts
portion of this document. The Contractor shall include eighty (80) hours of on-site assistance (excluding travel time) to be used after the final acceptance of the system. This assistance time is in addition to Warranty services and shall be performed on an on-call basis at the Employer’s request.

(a) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

(b) The Contractor shall upgrade each software package and firmware (where applicable) used in the system to the latest version by the end of the Warranty period.

(c) The Contractor shall offer an “Optional One (1) Year Extended Warranty” package renewable for up to five (5) years to the Employer. The Employer shall inform the Contractor of the acceptance or rejection of the first year of the package at the time of final acceptance.

(i) Installation personnel shall meet manufacturer’s training and education requirements for implementation of extended warranty program.

2 NEC Compliance: Comply with NEC as applicable to construction and installation of all system components and accessories including fire rating to all cables and enclosures as applicable.

3 UL Compliance and Labeling: Provide system components, which are UL-listed and labeled.

4 Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of that type of equipment and shall be the manufacturer’s latest standard design. Items of the same classification shall be by the same manufacturer and shall be the same series and model. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.

5 All technicians providing final wire terminations, configurations, and programming on major components shall be manufacturer certified and trained on products being installed under this project.

48.1.9 Delivery, Storage And Handling

1 Delivery: Deliver system components properly packaged in factory-fabricated type containers. Enclose an operating impact sensor in each container that is holding sensitive electronic equipment. The impact sensor shall be capable of recording a 5G rating.

2 Handling: Handle equipment and components carefully to avoid breakage, impact, denting and scoring finishes. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

3 Equipment delivered to the job site shall be opened and inspected immediately upon arriving and compared to the approved Shop Drawing submittal and checked for defects. If the equipment is not correct, the equipment shall be returned to the manufacturer immediately and a new order for the approved
equipment shall be placed at no cost to the Employer.

4 Equipment and components shall be protected from the prolonged exposure, weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Employer.

48.1.10 Definitions

1 Employer throughout the specifications refers to Public Works Authority (PWA).

2 Operator throughout the specifications refers to Primary Health Care Corporation (PHCC).

48.2 PRODUCTS

48.2.1 Manufacturer

1 Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

48.2.2 Master Clock Architecture

1 The Master Clock system shall be a stratum 1 GPS-based system for distributing accurate time and time correction signals throughout the facilities. The system shall distribute accurate time signals from two time servers to remote devices using standard Network Timing Protocol. The time servers shall be located in the main IDF room in the ground floor.

48.2.3 General Hardware Requirements

1 To ensure compatibility among network devices, all hardware equipment shall be supplied by a single manufacturer. Mixed equipment solutions are not acceptable.

2 All hardware requirements given are the minimum requirements. Contractor’s product shall meet or exceed these requirements. Additionally, the hardware selected shall meet the operational, functional, and performance requirements specified herein.

3 Hardware shall be ordered as close to the actual installation date for a given phase as possible. Final hardware approval and scheduled order date are at the sole discretion of the Employer.

4 Approved Equivalent Substitution: The Contractor may propose an Employer approved equivalent device. Requests for hardware substitution shall be submitted in writing and include the hardware cut sheet and the exact configuration being proposed.

5 Environmental Rating: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. For devices located in harsh environments such as interior uncontrolled or exterior environments, the Contractor shall provide the necessary housings or enclosures to ensure proper equipment operation and performance. The equipment shall meet the following requirements
based location:

(a) Interior controlled environment: 15 to 45 degrees C dry bulb and 20 to 90 percent relative humidity, non-condensing. Communication rooms shall be considered this type of environment.

(b) Interior, uncontrolled environment: 0 to 60 degrees C dry bulb and 10 to 95 percent relative humidity, non-condensing. Baggage make-up and breakdown areas shall be considered this type of environment

(c) Exterior environments: -5 degrees to 70 degrees C dry bulb and 5 to 100 percent relative humidity, condensing.

6 The Contractor shall provide all termination components to the data outlet including patch cords for a fully operational MC unless noted otherwise.

7 Enclosure Accessories: Contractor is responsible for providing fans, shelves, drawers, special power wiring, ground connections, cables, connectors, appurtenances, and adapters of any kind necessary to accommodate the system installation, operation, testing, or maintenance.

48.2.4 Master Clock Requirements

1 Software

(a) Provide NTP client software for Windows operating system, UNIX operating system and LINUX operating system

(b) Provide remote Administration software to manage the Time Server

2 Hardware

(a) Ethernet Wired Analog Clock Requirements: The Ethernet wired Analog clock shall meet the following engineering requirements:

(i) The Ethernet wired Analog clock consists of all metal construction and a polycarbonate lens for dependable operation with 24 hour face place, single or double faced, and a wall or ceiling mount bracket.

(ii) The Ethernet wired Analog clock shall be fully solid state and adopt state of the art technology.

(iii) The Ethernet wired Analog clock shall be compact, composite construction and lightweight. The manufacturers shall furnish the actual dimensions and weight of the equipment.

(iv) All connectors shall be reliable, low loss and standard type so as to ensure failure free operations over long operations.

(v) The Ethernet wired Analog clock shall be self-correcting from external NTP source and full-duplex mode.

(vi) The Ethernet wired Analog clock shall have 12" to 24" (30.5 to 61 cm) face

(vii) The Ethernet wired Analog clock shall be designed to provide for high availability.

(viii) Accuracy: 10 to 50 milliseconds typical

(ix) Protocols: SNTP, DHCP, HTTP, HTTPS and FTP
(x) Connectors: Ethernet 10/100 BaseT: RJ45
(xi) Power: PoE (Power over Ethernet) version

(b) GPS Antenna
(i) Rugged, all weather housing 12 channels GPS Antenna synchronization system operating over -20 Celsius to +80 Celsius temperature range
(ii) Mounting kit for masts
(iii) 100-Meter low loss coaxial cable
(iv) Out of band interference rejection

(c) Master Clock Time Server
(i) Alphanumeric Front Panel
  1) Two (2) lines x 80 characters LCD or LED display
  2) Keypad for manual data entry and status check
  3) Alarm status indicator
(ii) Supported Protocols
  1) SNTP, NTP v2, v3, v4, MD5 authentication,
  2) Broadcast/Multicast mode
  3) SNMP v1, v2c, v3 with Enterprise MIB
  4) TIME and DAYTIME server
  5) TELNET, FTP and DHCP client/server
(iii) Server Features
  1) 19-inch (483 mm) rack mountable with mounting accessories
  2) Time to lock: Less than five (5) minutes
  3) 10/100Base-T Ethernet interface
  4) RS-232 / USB I/O Console
(iv) Inputs
  1) GPS: SMA Antenna/preamp
  2) Time code: IRIG A, IRIG B 500 mV to 10 V p-p, >10KΩ
  3) Time Code: IRIG A, IRIG B Differential TTL, DCLS, 1KΩ
  4) 1 PPS: TTL, Active rising or falling
(v) Outputs
  1) Time code: (Optional) IRIG B, Modulated 3:1, 3V p-p, 75Ω
  2) Time code: (Optional) IRIG B, Differential TTL, DCLS, 50Ω
  3) 1 PPS: TTL, Rising edge on-time, 50Ω
  4) Frequency: 10 MHz, 50Ω
(vi) Power
  1) 220 VAC, 60 Hz

48.2.5 Performance Requirements

1 General: The standards in the following sections apply to the entire system unless noted otherwise. Each individual device provided now or in the future by the Contractor shall meet these standards as a minimum:

(a) Timing Characteristics:
   (i) Network: 1-10 milliseconds
   (ii) Accuracy: < 0.0000000001 seconds to UTC for 24-hour averaging times when locked.
   (iii) Stability: < 0.000000001 seconds
   (iv) Automatic Daylight Saving switching

(b) The system shall be capable of supporting all interfaces as specified in this document within the performance requirements as outlined herein.

(c) System Availability: At any given time, the overall MC shall be considered unavailable if the system is not available, not fully or accurately functional, or does not meet performance criteria for the given connection. All MC components shall execute, without degradation, at the scheduled periods and response times for the systems to be considered available. The systems shall operate as specified twenty-four (24) hours per day, seven 7 days per week. Availability of the overall MC shall be at least 99.999% (5 minutes maximum downtime per year).

48.2.6 External Interfaces

1 The Contractor shall coordinate with the Employer and other contractors the requirements for connectivity to the network.

48.2.7 Quantities

1 Provide two (2) Time Server units. The units shall be physically in the Main IDF room.

2 The Contractor shall develop the final quantities for the clocks required throughout the buildings upon confirmation of the type and model with the Employer.

48.2.8 Expansion And Spares

1 The Contractor shall clearly state limitations of the proposed system in terms of adding additional capacity. Particular attention should be given to the number of clients served before which additional unit would be required.

2 5% Spares for the Master Clock System for the following items.
   (a) Analog Clocks

3 2% Spares for GPS antennas, but not less than ten (10) antennas.
Cable: Comply with Part 14 - Structured Cabling Network.

48.3 EXECUTION

48.3.1 Examination

1. The Employer assumes no responsibility or liability for transportation from country of origin, storage fees, drayage, import taxes, duty taxes, or other costs associated with the delivery and storage of system components.

2. Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the Employer.

3. Contractor shall store products in accordance with manufacturer's instructions, within Contractor's staging area and with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

4. Contractor shall provide coverings to protect products from damage from traffic and construction operations, remove when no longer needed.

5. Contractor shall ensure that all work performed under these Specifications is in accordance with the requirements and standards defined and referenced in these Specifications. Any work performed in deviation of these Specifications, any of the referenced material, or any applicable standards or requirements, shall immediately be corrected by the Contractor without additional charges, regardless of the stage of completion. The Contractor shall record all inspection observations. As a minimum, the record shall include the name(s) of personnel conducting the inspection, a brief description of the inspection and the observations. These records shall be available for the Engineer to review at any time. Also, these records shall be delivered to the Engineer before final acceptance.

6. Installation Inspections: Installation inspections shall be undertaken through the performance of pre-installation, in-progress, and final inspections as follows:

7. Pre-Installation Inspection: The Contractor shall make an inspection of all equipment and material to be used prior to installation. All items shall be verified for compliance with the requirements of these Specifications and all other applicable standards. All equipment, cable, and associated hardware identified for installation shall be inspected for damage and completeness utilizing standard practices to determine integrity and acceptability.

8. In-Progress Inspection: At the Engineer’s discretion, the Contractor shall perform in-progress inspections that shall include visual inspections of equipment, wiring practices, cabling, placement of equipment, marking of cables and adherence to safety procedures. In addition, the Employer, or his representative, may conduct additional inspections any time.

9. Final Inspection: The Contractor shall conduct a final inspection that encompasses all portions of the installation. This inspection shall be performed to ensure that all aspects of the installation have been performed in accordance with these Specifications, standard industry practices and the publications referenced herein. All non-compliance items shall be noted by the Contractor.
during this inspection. The Engineer shall witness this inspection.

10 Corrective Action and Verification Inspection: The Contractor shall perform all corrective actions to ensure that all non-compliance items identified during the final inspection have been corrected.

48.3.2 Installation

1 Standards: All installation activities shall be performed in a neat and professional manner in accordance with all applicable local and national codes. Additionally, the Contractor and all subsequent Sub-Contractors employed to satisfy the requirements of these specifications shall obtain, or satisfy, the following prior to installation:

(a) All licenses and permits
(b) All insurance and bonding as required
(c) All other standards or requirements specified in this document
(d) Contractor shall install and inspect all hardware required in this specification in accordance with the manufacturer's installation instructions.

2 Contractor shall adhere to the following during installation of the system:

(a) Underwriter’s Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electric Code for customer premise installations.
(b) Fire resistance requirements specified by Underwriter's Laboratories in UL 1459, 2nd edition.

3 Where undefined by codes and standards, Contractor shall apply a safety factor of at least two (2) times the rated load to all fastenings and supports of system components.

4 Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

5 Rack Mounted Equipment:

(a) As a general practice, Contractor shall run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the rear.
(b) The Contractor shall run other cables on the right side of an equipment rack, as viewed from the rear.
(c) For equipment mounted in drawers or on slides, provide the rack accessories as well as interconnecting cables with a service loop of not less than three feet and ensure that the cable is long enough to allow full extension of drawer or slide.

6 Contractor shall install all custom and packaged software in the development and production environments’.
7 Contractor shall provide a migration plan for all new and updated software to be migrated from within the development environment to the production environment.

8 Final hardware selected and installation of hardware shall be submitted for review by the Engineer. Additionally, the Contractor shall review the cabinets and equipment room to ensure ventilation requirements are met or recommend modifications.

9 Contractor shall install and configure all software required in this Specification in accordance with the software manufacturer’s installation instructions. Apply the latest patches and security updates. Register the application with the manufacturer under the Employer’s name.

10 The contractor shall facilitate, configure, document and test all network connections required by other systems or other facilities not in contract that require access to the network specified herein.

11 Contractor shall place materials only in those locations that have been previously authorized. Any other locations shall be authorized, in writing, by the Engineer.

12 Contractor shall provide all tools, applications and test equipment required to install, verify, and test the installation and to determine that it meets the specifications. The Contractor shall furnish all necessary materials required to implement and to achieve the required work performance.

13 Clocks: Perform the following operations with each clock:

   (a) Set clock to correct time in accordance with manufacturer’s instructions.

14 Install clocks on the wall in the indicated location, plumb, level and tight against the wall. Attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer. Provide silicone sealant in rooms where required by architect.

48.3.3 Documentation

1 This Part requires complete documentation of all systems for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts. All documentation, as described herein shall be submitted to the Engineer for approval sixty (60) days prior to final submission.

2 Scope: The Contractor shall provide the Employer with Operation and Maintenance Manuals and other documentation on all installed systems. These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.
3 The maintenance manual requirement of this Part is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing, and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.

4 Maintenance Manuals, Manufacturer's Literature: Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.

5 Drawing Books: All Drawings developed specifically for this Project shall be reduced to half-size, folded and bound with hard plastic covers. The half-size Drawings provided shall be easily readable after printing, even if this requires breaking large Drawings into several parts. Text shall be no smaller than 2 mm. The drawing book documents shall be produced with current version of AutoCAD and the electronic files shall be provided to the Employer at the completion of the Project on DVD/CD-ROM. Provide component identification and cross reference on the Drawings to allow the maintenance department to understand the function of each item (the block diagram), find the room where the device is mounted (Contract Document plans), find its location in a rack (Arrangement Drawings), find how it is wired (wiring diagrams), and its detailed Specifications (vendor data sheets), and how to repair it (spare part lists). Include the following drawings as a minimum:

(a) System Block Diagram: This drawings shall depict the final LAN overview, including equipment types, location, IP addresses and any special information

(b) System Riser Diagram(s): These drawings shall show all LAN components, wire numbers, color codes, pin numbers, component locations and connections, depicting the “as-built”, final configuration

(c) Rack Elevation and Wiring Diagram(s): The elevation diagrams shall depict the front views of the equipment racks identifying all equipment installed within. Complete wiring diagrams of the racks shall also be included

(d) Floor plans of the communications rooms showing the location of all equipment effected as a part of this contract within the communications rooms

(e) Elevation drawings of all wall mounted equipment showing the location of each component on the wall. Components on the walls shall be identified as in the functional block diagrams

(f) Wiring Diagrams: Provide wiring diagrams showing all field installed interconnecting wiring. Wire identification on the diagrams shall agree with the wire markers installed on the equipment

(g) System Administrator Documentation: The Contractor shall supply three (3) hardcopies of administrator documentation and three (3) copies of the documentation in PDF format on CD-ROM that detail the operation of the system. This documentation shall provide complete information on the configuration, business rules, operation, maintenance, and trouble-shooting of the system
6 Warranty: The Contractor shall supply all warranties as required in the “Warranty” article of this specification.

48.3.4 General Testing Requirements

1 Phases of Testing:
   (a) Factory Acceptance Testing
   (b) Integration Testing
   (c) Endurance Testing

2 Project Testing: The system installation shall not be considered complete until On-Site Endurance Testing are completed. The purpose is to test the complete system and demonstrate that all specified features and performance criteria are met. All requirements of the specification shall be tested, including:
   (a) Functionality, including reporting and response
   (b) System capacity
   (c) Hardware and software interaction
   (d) Failure Recovery
   (e) Report generation

3 Test Plan/Procedure: Contractor shall provide six (6) copies of the proposed test plan/procedures for each testing phase for the review of the Engineer. The test plan for each phase of testing shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The submission of Test Plans shall adhere to the following:
   (a) A draft test plan shall be presented to the Engineer at least forty-five (45) days prior to the scheduled start of each test
   (b) A workshop for reviewing comments shall be conducted with the Engineer at least thirty (30) days prior to the scheduled start of each test
   (c) A final test plan shall be submitted to the Engineer at least fourteen (14) days prior to the scheduled start of each test

4 Test plans shall contain at a minimum:
   (a) Functional procedures including use of any test or sample data
   (b) Test equipment is to be identified by manufacturer and model including LAN analyzers and packet sniffers
   (c) Interconnection of test equipment and steps of operation shall be defined
   (d) Expected results required to comply with specifications
   (e) Traceability matrix referencing Specification requirements with specific test procedures
   (f) Record of test results with witness initials or signature and date performed
   (g) Pass or fail evaluation with comments
5 The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.

6 All Test plans must be reviewed by the Engineer. To successfully complete a test, the test document must be signed and dated by both the Contractor and the Engineer.

7 The Engineer will review, witness and validate the execution of all formal test procedures prepared by the Contractor and deliverable under the contract to assure the tests cover all requirements and that there is a conformity between the conducted test, the test results and Specification requirements.

8 Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.

9 The Contractor shall provide the Employer or Employer representative the opportunity(s) to participate in any or all of tests.

10 Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Six (6) copies of the test report shall be submitted to the Employer representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:

(a) Commentary on test results
(b) A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution
(c) Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test
(d) Signatures of persons who performed and witnessed the test

11 Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to Employer. The problems identified in each phase shall be corrected and the percentage of the entire system re-tested determined by the Engineer before any subsequent testing phase is performed.

48.3.5 Factory Acceptance Testing

1 The purpose of this test is to validate that the individual systems components function as standalone equipment and all specified features are met.

2 The Contractor shall ensure that development of the system is complete, required approvals of submittals have been obtained, and sufficient equipment has been procured to completely demonstrate and test the system.

3 Factory Acceptance testing shall be completed at an Employer authorized test site.

4 Test Setup Equipment: Equipment shall be the actual products or identical
models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting pre-delivery test:

(a) Equipment associated with the system
(b) Devices associated with system
(c) Software associated with system
(d) Administrative tools and equipment
(e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

5 Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer authorized personnel.

6 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

7 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

8 Reporting:
   (a) Record all test procedures and results
   (b) Submit report in accordance with reporting requirements in General Testing Requirements Section.

48.3.6 Integration Testing

1 The purpose of this test is to validate integration between the system and other interfaced subsystems or systems and to demonstrate that all specified features are met. All requirements of the LAN integration shall be tested including connectivity, interaction, interface, format, and data flow.

2 Integration testing shall be completed at the systems integration laboratory or other authorized location on-site at the campus. Interfaces may be tested using simulated data to/from other systems.

3 Test Setup Equipment: Equipment shall be actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting the test:

(a) Equipment associated with the system
(b) Devices associated with system
(c) Software associated with system
(d) Administrative tools and equipment
(e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

4 Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by
additional Employer personnel.

5 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

6 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

7 Reporting:
   (a) Record all test procedures and results
   (b) Submit report in accordance with reporting requirements in General Testing Requirements Part

48.3.7 Endurance Testing

1 The purpose of this test is to validate that the fully integrated system meets the Endurance and High Availability requirements.

2 Integration testing shall be completed on-site at the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor. All interfaces shall be tested using actual interfaces to other systems (i.e. no stubs or dummy data.)

3 Requirements:
   (a) Provide personnel to monitor system operations 24 hours per day, including weekends and holidays during Endurance Testing
   (b) Start test after:
      (i) Successful completion of Integration Testing
      (ii) Training as specified has been completed
      (iii) Correction of deficiencies has been completed
      (iv) Receipt of written start notification from the Engineer
   (c) Monitor all systems during Endurance Testing. Coordinate monitoring with the Engineer
   (d) Recording: Record data on forms so as to provide a continuous log of systems performance. Include:
      (i) Date and time for all entries
      (ii) Name of individual making entry
      (iii) Environmental conditions
      (iv) Activities in process
      (v) Description of all alarms, responses, corrective actions, and causes of alarms. Classify as to type of alarm
      (vi) Description of all equipment failures, including software errors
      (vii) Description of all maintenance and adjustment operations performed on system
      (viii) Daily and weekly tabulations
Daily entries of performance data shall be reviewed by the Engineer

Employer may terminate testing at any time when the system fails to perform as specified. Upon termination of testing the Contractor shall commence an assessment period as described in Stage II.

4 Testing

(a) Stage I - Initial Phase Testing:
   (i) Time: 24 hours per day for 30 consecutive calendar days
   (ii) Make no repairs during this stage unless authorized in writing by the Engineer
   (iii) If system experiences no failures, proceed to Stage III - Final Testing

(b) Stage II - Initial Phase Assessment:
   (i) After conclusion of Stage I, or terminating of testing, identify all failures, determine causes, and repair. Submit report explaining: Nature of each failure, corrective action taken, results of tests performed to verify corrective action as being successful, and recommended point for resumption of testing
   (ii) After submission of report, schedule review meeting at job site. Schedule date and time with the Engineer
   (iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
   (iv) Based on report and review meeting, the Engineer will direct Contractor to repeat Stage I, restart Stage I, or proceed to Stage III - Final Testing

(c) Stage III - Final Phase Testing:
   (i) Time: 24 hours per day for 15 consecutive calendar days
   (ii) Make no repairs during this stage unless authorized in writing by the Engineer

(d) Stage IV - Final Phase Assessment:
   (i) After conclusion of Stage III or termination of testing, identify all failures, determine causes, and repair. Submit explaining the nature of each failure, corrective action taken, results of tests performed, and recommended point for resumption of testing
   (ii) After submission of report schedule review meeting at job site. Schedule date and time with the Engineer
   (iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
   (iv) Based on report and review meeting, the Engineer will review Endurance Test or direct Contractor to repeat all or part of Stages III and IV

5 Adjustment, Correction, and Maintenance

(a) Adjustment and Correction: Make adjustments and corrections to system
only after obtaining written approval of the Engineer
(b) Maintenance: Perform required maintenance on systems including provision of replacement parts

6 Final Inspection and Acceptance
(a) After Endurance Testing is complete, review tabulated records with the Engineer
(b) Contractor will not be responsible for failures caused by:
   (i) Outage of main power in excess of backup power capability provided that automatic initiation of all backup sources was accomplished and automatic shutdowns and restarts of systems performed as specified
   (ii) Failure of any Employer furnished power, communications, and control circuits provided failure not due to Contractor furnished equipment, installation, or software
   (iii) Failure of existing Employer equipment provided failure not due to Contractor furnished equipment, installation, or software
(c) When performance of system does not fall within the above parameters, determine cause of deficiencies, correct, and retest
(d) When requested by the Employer, extend monitoring period for a time as designated by the Employer
(e) Period shall not exceed 60 days exclusive of retesting periods caused by termination of Stages I or III and assessment period of Stages II and IV
(f) Submit final report of Endurance Testing containing all recorded data

48.3.8 Maintenance and Support
1 General
(a) The Contractor shall provide maintenance and support of all components associated with this system at no additional charge during the warranty period. This extends to systems requiring vendor pre-purchased maintenance agreements.
(b) The Contractor shall supply a list of special tools, test equipment, and outside inventory required for this Project. The Contractor may recommend specific items to facilitate long-term support of the system as an option to the Employer.
(c) All lead technicians performing installation and maintenance shall have a minimum of two (2) years experience on the proposed system and be manufacturer certified on all hardware/software applications. All maintenance technicians shall be provisioned to attend a one (1) week manufacturer training class each year. Pre-assigned backup technicians shall be available to backfill for onsite technicians who are on vacation, in training or who are out sick
(d) The Contractor shall provide twenty-four (24) hours/seven (7) days a week telephone support as a minimum maintenance and support agreement. Additionally, the Contractor shall specify a maximum amount of time to get the system up and operational in the event of a system failure. This time
2 Hardware and Software Support

(a) Hardware and Software support shall be supplied by the Contractor directly or by a Sub-Contractor reviewed by the Employer. Support shall cover all equipment and systems referenced in this Specification

(b) The Contractor shall assume full responsibility for the performance of all equipment supplied by the Employer, provided that such equipment meets the specifications set forth by the Contractor

(c) All software shall be delivered with an installable backup

3 Pricing after Warranty Period: Cost of maintenance and support on a yearly basis after the Warranty period has expired, shall be included as an option to be exercised by the Employer or his designated representative. Contractor shall clearly state in the bid the annual cost and availability of the following services that the Employer may wish to use or to continue after the initial Warranty period has expired (Costs shall be given for a three (3) years with additional two (2) years to be renewed on an annual basis):

(a) Costs of maintenance of the equipment and software

(b) Cost of software and firmware upgrades

(c) Telephone consultation support

(d) Technicians on-site (including travel, meals and lodging) to repair or replace malfunctioning equipment or software, if not covered in the maintenance costs above

(e) Programming on message text, animation sequences, and the like for Employer use and operation

4 Definitions

(a) Preventive and Routine Maintenance: Preventive and routine maintenance services shall be provided in accordance with the provisions of the maintenance manual for each component. Preventative maintenance services shall include inspection, test, necessary adjustment, lubrication, parts cleaning, and upgrades. Routine maintenance services shall include scheduled overhauls as recommended by the equipment manufacturer

(b) Emergency Failure: A system failure is considered an emergency if any of the key components are inoperative to the extent the system cannot function in a normal manner. Emergency services shall include inspections and necessary tests to determine the causes of equipment or software malfunction or failure. The emergency services shall include furnishing and installing components, parts, or software changes required to replace malfunctioning system elements. The Contractor shall provide telephone support twenty-four (24) hours a day, seven (7) days a week. The Contractor shall provide support on-site within eight (8) hours of request.

(c) Support: Support shall be supplied by the Contractor directly or by a sub-Contractor reviewed by the Employer. Support shall cover all equipment referenced in this specification
48.3.9 Cleaning

1 Upon completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

48.3.10 Training

1 The User Training shall include on-the-job-training of at least two (2) weeks. The training shall be conducted on site at the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor.

2 The System Administrators Training shall include on-the-job training. Six (6) weeks of on-the-job training shall be provided. This training shall be conducted on site at the Health Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor.

3 The Contractor shall provide the Employer specified trainees with detailed As-built information by the Contractor Lead Network Engineer. The training shall provide the system Administrators with a working knowledge of the system design and layout, and shall provide troubleshooting methods and techniques. In addition, the training shall cover testing, maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.

4 Course materials shall be delivered to the Employer. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the Employer. The Contractor shall supply a videotape of each training course.

5 All training shall be completed a minimum of two (2) weeks prior to the system becoming operational and utilized by the Employer. Training schedule subject to the Employer's review.

48.3.11 Acceptance

1 The Contractor shall not apply power to the system until after:

   (a) System and components have been installed and inspected in accordance with the manufacturer's installation instructions

   (b) A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections

   (c) System wiring has been tested and verified as correctly connected as indicated

   (d) All system grounding and transient protection systems have been verified as properly installed and connected, as indicated

   (e) Power supplies to be connected to the system and equipment have been verified as the correct voltage, phasing, and frequency as indicated

2 Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3 Acceptance will be withheld until the following have been completed successfully:
(a) Acceptance of all submittals
(b) Successful testing and delivery of approved test results
(c) Completed Training as per the specifications as well as successful demonstration of the operation of the entire system
(d) Final cleanup of the system and work areas
    Delivery of all documentation including accepted As-built documentation.
Add the following completely new Part titled: Part 50 – Public Address System including its new clauses as follows:

50. PUBLIC ADDRESS SYSTEM

50.1 GENERAL

50.1.1 Summary

1. Drawings and general provisions of the Contract, including Terms of Reference and all contractual conditions apply to this Part.

2. All Specifications listed in this specification shall be used as functional performance-based specifications. The Contractor shall be responsible for completing and coordinating requirements necessary to design, furnish and install fully engineered and functional systems. These requirements include any site analysis, furthering of design documents, determination of quantities of equipment, verification of existing conditions and external service providers, and the like. It shall be the responsibility of the Contractor to provide any additional equipment, software, arrangements or infrastructure necessary to complete the system commissioning.

3. This Part includes a full featured public address system for the Health Care Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor.

50.1.2 References

1. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

2. Specific reference in Specifications to codes, rules regulations, standards, manufacturer’s instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at date of Contract unless the Document is shown dated.

3. Comply with all local codes and requirements of Authorities Having Jurisdiction (AHJ).

4. References:

   (a) ASTM: American Society for Testing Materials
   (b) ANSI: American National Standards Institute – All EIA relevant standards
   (c) Institute of Electrical & Electronics Engineers (IEEE).
   (d) Building Industry Consulting Service International (BICSI).
   (e) Federal Communications Commission (FCC) regulations and standards.
   (f) IEC 603-7
   (g) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.
   (h) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables
Burning under Defined Conditions.

(i) IEC 60331 Part 11 & 12, Tests for Electric Cables under Fire Conditions.

(j) IEC 60332 Tests on Electric Cables under Fire Conditions.

(k) IEC 60364-1 Electrical Installations of Buildings, Fundamental Principles, Assessment of General Characteristics, Definitions.

(l) ICEA: Insulated Cable Engineers AssociationS-84-608-1994 Telecommunications Cable, Filled, Polyolefin Insulated Copper Conductor

(m) IBC: International Building Code 2006

(n) ISO: International Organization for Standardization

(o) NFPA: National Fire Protection Association

(p) NFPA 70 (2008)

(q) NFPA 72 (2010)

(r) NFPA 101 (2009 ed.)

(s) NFPA 780 (2008)

(t) NFPA 5000 (2006 ed.)

(u) NFPA 101 National Life Safety Code

(v) NEMA: National Electrical Manufacturers Association (NEMA)

(w) NESC: National Electrical Safety Code

(x) UL: Underwriters Laboratories

(y) UL 83 Thermoplastic Insulated Wire and Cables

(z) UL 96 Lightning Protection Components

(aa) UL96A Installation Requirements for Lightning Protection Systems

(bb) UL 467 Grounding and Bonding Equipment

(cc) UL 497 Protectors for Paired-Conductor Communication Circuits

(dd) OSHA: Occupational Safety and Health Agency

(ee) Local/National Electrical codes.

(ff) Local/National Health & Safety codes.

(gg) Local and national regulations and codes in effect as of date of purchase.

5 All Local Codes shall prevail. Where local Codes are silent, National Codes and Standards shall be applied. Codes, rules, regulations, and ordinances governing the work, are as fully part of the Specifications as if herein repeated or attached.

If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Engineer in writing.

6 Design and Install cabling in accordance with the most recent edition of Building Industry Consulting Services International (BICSI®) publications.

7 Conflicts: Where the requirements of the specifications conflict with other documents the following shall apply:
(a) Between Plans and Specifications, between different specifications, or between different plans: Comply with the one establishing the more stringent requirement.

(b) Between referenced requirements or between industry standards: Comply with the one establishing the more stringent requirements.

(c) Between referenced requirements and Contract documents: Comply with the one establishing the more stringent requirements.

50.1.3 Related Parts

1 Structured Cabling Network

50.1.4 Scope of Work

1 Provide a complete Public Address System as specified herein and indicated on the drawings. The system shall include but not be limited to power amplifiers, digital signal processing, speakers, paging stations, system servers, programming, software, cable, terminations and all accessories required for a complete operating system.

2 The Public Address System shall be a multi-function announcement management and distribution system utilizing servers and digital processing to perform system, operation and controls. The system shall include distributed controls and amplifiers.

3 The Public Address System server shall manage and control all system functions and hardware including paging stations, telephone interfaces, distribution of emergency announcements, local announcements, building wide announcements, background music, recorded announcements, pre-recorded and assembled messages.

4 The Public Address System is comprised of several integrated sub systems that form a complete system for announcement and message management. These systems shall include:

   (a) System Server for user configuration and control.
   (b) Web browser based software for announcement control.
   (c) Digital Recording and Playback system.
   (d) Equalization system.
   (e) Automatic Test and Monitor system.
   (f) Paging Stations.
   (g) Redundant Power Supply systems.
   (h) Power Amplifier systems.
   (i) Speakers

5 All 70V speaker cable shall be installed in metal raceway system.

50.1.5 Qualifications

1 Project Qualifications
(a) The Contractor must currently be and have been in the business of selling, installing, and maintaining similar systems at large healthcare facilities for a minimum of five (5) years. The Contractor must have been actively engaged in designing, installing, maintaining and operating similar systems and services as outlined in this document.

(b) The Contractor must have a minimum of three (3) sites that are actively using the same or similar solutions, and each of those solutions must be currently in operation, and have been in operation for at least the preceding twelve (12) months.

(c) The Contractor is required to submit information regarding a minimum of three (3) reference sites that are actively using the same or similar systems. The sites should be similar in terms of number of equipment, devices throughput, and network operations. This reference information shall include the contact name, address, telephone number, and date of original installation for each reference site listed. Additionally, for each reference site detail the features that make it a qualified site (e.g., final system acceptance date, number of devices, etc.).

2 Organization Qualifications

(a) The Contractor shall provide a complete description of organizations and/or firms involved including:

(i) Involvement of subcontractors or product vendors

(ii) The name of the Team Leader responsible for the project coordination, development and ongoing Implementation

(iii) Detailed description of the team and organization chart noting its structure

(iv) Résumés for key personnel

(v) Specific role definition including provision for leadership, technical control, teamwork, partnering, coordination and communication

(vi) Percentage of time committed for the project by each key personnel

(vii) Mobilization plans for the different phases of the project

(viii) Listing of all current projects where there is an overlap or potential for overlap of manpower resources. For these projects provide a detailed description of the role, committed level of effort, schedule and completion date for each key individual of the proposed team.

(b) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

50.1.6 Submittals

1 Proposal Submittals:

(a) In addition to all required proposal submittals listed in the appropriate Division, the Contractor shall provide the following submittals:

(i) Design Approach: In designing the systems, it is desired to standardize hardware, operating systems, etc. in order to facilitate
long-term maintenance of the systems. However, the Contractor may propose an alternative solution to any of the design requirements. These alternatives shall be clearly delineated and shall be bid as options, in addition to the base design. Preference shall be given to vendor solutions which best integrate into the overall system design.

(ii) References: The Contractor is required to submit data sheets for same or similar implementations as specified in the “Qualifications” article of this specification.

(iii) Qualifications: The Contractor shall supply qualification data sheets for firms and persons as specified in the “Qualifications” article of this specification to demonstrate their capabilities and experience.

2 B. Contract Submittals:

(a) Work Plan and Schedule: The Contractor shall supply a schedule of proposed installation and implementation, including dates and milestones within 30 days of contract award. Updates shall be submitted monthly.

(b) Proposed product data sheets: The Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification Part reference for each product. Product data sheets shall be bound in a three ring binder and shall include a product index listing the model number and description of product.

(c) Samples: Submit one sample of the product components and if required a complete assembly.

(d) System Block Diagram: The Contractor shall supply a block diagram that depicts the final system design, including riser diagrams, logical flow, single line diagrams, databases, application servers, communication and distribution methods, and external interfaces.

(e) Configuration: Submit complete lists of all proposed configuration setups, business rules, process flows, and processes implemented in the system. Lists must be submitted weekly during the project and thirty (30) days prior to any formal testing.

(f) Parts Lists: The Contractor shall supply complete Systems parts lists and breakdowns that identify each component (to the lowest repairable unit) as well as ordering information for these parts shall be provided. The characteristics of each component shall also be shown, where applicable, to aid in obtaining substitute parts. Schematics and parts layout drawings to the component level are to be provided when available. The Contractor shall supply a complete list and cross-reference of all supplied documents (i.e., name, brief description, and document number).

(g) Test Plans, Test Procedures and Test Reports: Indicate testing methods, devices, and procedures. Progress payments shall depend on the successful completion of testing and documentation. Provide the test plan at least forty five (45) days prior to the scheduled start of the first test. The test plan shall detail the objectives of all tests and samples of all proposed test forms.

(h) Manufacturers’ system manuals for each system/component provided under the referenced specification Part, including:
(i) Design and Installation.
(ii) Operation/System Administration.
(iii) Maintenance and Service.
(iv) End-user.

(i) Training Plan: Indicate proposed training methods as specified in the “Training” Part of this specification.

(j) Progress Schedule – Contractor shall submit to Project Engineer estimated construction progress schedules for the Work.

(k) Compliance Matrix: Contractor shall submit a compliance matrix that summarizes compliance or non-compliance with each specification component.

3 Supply all documents necessary to enable users to operate all systems and to change feature assignments and software parameters without assistance from the Contractor. This includes a complete listing of all software parameters of the system.

4 Record Drawings: Furnish hardcopy and electronic drawings, in AutoCAD latest format, of completed work including labeling, where applicable.

50.1.7 Warranty

1 General:

(a) The Contractor shall warrant complete installation of the equipment, system, and software to be free from defects in materials and workmanship for a period of no less than twenty-four (24) months, starting with the date of Substantial Completion. As an option, the Contractor shall supply pricing for an extended Warranty of the system. This option shall be renewable on a yearly basis, and pricing shall be supplied for a minimum of five (5) years from the expiration of the initial Warranty.

2 Hardware Warranty:

(a) The Contractor shall warrant that the proposed hardware equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. This Warranty shall be in addition to any standard Warranty or service guarantee given by the Contractor to the Employer.

(b) The Warranty shall allow for replacement or repair of failed systems, equipment and components.

(c) The hardware warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(d) All hardware installed without an on-site spare shall have a twenty-four (24) hour repair/replacement Warranty from the time the Contractor is notified of the hardware failure.

3 Software Warranty:
(a) The warranty shall allow for replacement or repair of failed components. All software necessary to compile, modify, and maintain software supplied for this specification shall be included in this warranty.

(b) The software warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(c) The warranties shall include the price of all software upgrades and computer operating system upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

50.1.8 Quality Assurance

1 General: In addition to the general requirements, the Contractor must have been in the business of selling and installing similar systems for a minimum of five (5) years. The Contractor shall have been actively engaged in installing, maintaining and operating similar systems and services as outlined in the Related Parts portion of this document. The Contractor shall include eighty (80) hours of on-site assistance (excluding travel time) to be used after the final acceptance of the system. This assistance time is in addition to Warranty services and shall be performed on an on-call basis at the Employer’s request.

(a) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

(b) The Contractor shall upgrade each software package and firmware (where applicable) used in the system to the latest version by the end of the Warranty period.

(c) The Contractor shall offer an “Optional One (1) Year Extended Warranty” package renewable for up to five (5) years to the Employer. The Employer shall inform the Contractor of the acceptance or rejection of the first year of the package at the time of final acceptance.

(i) Installation personnel shall meet manufacturer’s training and education requirements for implementation of extended warranty program.

2 NEC Compliance: Comply with NEC as applicable to construction and installation of all system components and accessories including fire rating to all cables and enclosures as applicable.

3 UL Compliance and Labeling: Provide system components, which are UL-listed and labeled.

4 Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of that type of equipment and shall be the manufacturer’s latest standard design. Items of the same classification shall be by the same manufacturer and shall be the same series and model. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.
5 All technicians providing final wire terminations, configurations, and programming on major components shall be manufacturer certified and trained on products being installed under this project.

50.1.9 Delivery, Storage and Handling

1 Delivery: Deliver system components properly packaged in factory-fabricated type containers. Enclose an operating impact sensor in each container that is holding sensitive electronic equipment. The impact sensor shall be capable of recording a 5G rating.

2 Handling: Handle equipment and components carefully to avoid breakage, impact, denting and scoring finishes. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

3 Equipment delivered to the job site shall be opened and inspected immediately upon arriving and compared to the approved Shop Drawing submittal and checked for defects. If the equipment is not correct, the equipment shall be returned to the manufacturer immediately and a new order for the approved equipment shall be placed at no cost to the Employer.

4 Equipment and components shall be protected from the prolonged exposure, weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Employer.

50.1.10 Definitions

1 Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

2 Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

50.2 PRODUCTS

50.2.1 Manufacturers

1 Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

50.2.2 Public Address System (PAS)

1 The PAS shall be distributed in structure, with no central point of failure.

2 The PAS shall transport all digital audio data, including all recorded and live voice messages, preambles, background music and other audible signals, routine or emergency. The monitoring and control data carried to and from each PAS device. This audio traffic shall be standard cobranet at a sample rate of 48Khz.

3 PAS components shall be continuously monitored for presence, proper function and faults. Faults must be logged internally to the unit and be able to be viewed by PAS software.
4 PAS preambles, voice prompts and recorded announcements shall be WAV file format.

50.2.3 Priority of Messages

1 Broadcasting of live messages shall be either initiated directly by an authorized person from the main or sub-operation consoles or from a microphone station anywhere in the project.

2 In this situation, the message shall mute the lower priority signals (BGM, etc)

3 A programmable priority scheme shall ensure no conflict between messages designated to areas, and shall allow simultaneous announcements at different areas.

4 Fire alarm messages shall have absolute priority over all other signals and shall be supervised by the PA and the FA systems.

5 A special module in the PA main system shall handle these messages and perform interfacing functions so as to be appropriate for handling by the PA system.

6 Local announcements from a gate call stations can be initiated by the authorized person according to its priority in the overall scheme. A busy indication signal shall be indicated to the person that the system is not ready to broadcast his message as being busy with higher or equal priority broadcast.

7 A message originated from any location shall be transmitted in digital form to its appropriate destination together with the necessary commands required to the appropriate equipment.

50.2.4 Life Safety Interface Appliance

1 The Public Address system shall be used to broadcast fire alarm evacuation messages, public announcements, background music (BGM).

2 Voice evacuation messages shall be broadcasted by the Public Address system using the appropriate hardware and software modules required for interfacing between the Public Address and the Fire Alarm systems, which shall be totally supervised by the FA system. PA system shall also broadcast announcements.

3 The public address system shall be modular and shall allow for future extension.

4 The Public Address System shall receive a stop signal from Fire Alarm System in case of fire.

5 The extent of work of the Public Address System is indicated on Drawings, schedules and riser diagrams.

6 The Public Address system shall be interfaced with fire alarm and BAS systems.

50.2.5 Paging Stations

1 Paging Microphone stations shall be located at each gate and information desk and in other locations as shown in drawings and riser diagrams.
2 The microphone station (MS) shall be used to broadcast local messages on small scales.

3 The Number of Zones per Microphone stations are as indicated in the Single line diagrams.

4 Each MS shall include a microphone, a 30 W power amplifier, intelligent control module and operating switches.

5 Initiation of a message from any MS shall be managed by the PA central control, which sets priorities and controls its function, which shall either allow the broadcast or deny it and give a busy signal, which shall continue until it is clear to broadcast.

6 In case the broadcast is allowed, the control module of the MS shall switch the group of loudspeakers related to the MS from the PA system to it for the period of broadcast and reset automatically to normal.

7 In all situations the status shall be displayed at the OC and at the related MS (clear, busy, override).

8 Each Microphone station shall be provided by a General Call button programmed according to the operation and evacuation requirements for the terminal.

9 The Main Station shall be located at the Terminal operation room and shall include General call button for all the terminal, Arrival, departure and the finger buildings.

10 The Microphone station shall have the following specs:
   (a) Impedance: 150 ohms.
   (b) Frequency Response: Uniform, 50 to 14,000 Hz.
   (c) Output Level (1 kHz): -54 dB (0dB = 1 mw/ μbars)
   (d) Output Level: Minus 58 dB, minimum.
   (e) Mounting: Desk stand with integral-locking, press-to-talk switch.

50.2.6 Interior Recessed Speakers

1 Ceiling Speaker: Ceiling speaker shall be used at corridors and Halls, Toilets, Lobbies, shops, Lounges.

2 The ceiling speaker shall have the following characteristics:
   (a) SPL at 1W/4KHZ/1m: 94 dB
   (b) Frequency Response: -10 dB from 80 Hz to 18 kHz
   (c) Rated Output Level: 1.5/3/6 W rms and according to Contractor's / supplier acoustic study of area and manufacture recommendation.
   (d) Opening Angle @4KHZ: 65 degree
   (e) Shall have 100V matching transformer.
3 Full power matching transformer rated with four EIA standard taps and matched with audio power transmission voltage including taps for 1, ½, ¼ of the rated output power.

4 Acoustically damped enclosure type speakers, wooden or plastic enclosures shall be used speakers and matching transformer.

5 Construction with provision for relief of backpressure except if they are acoustically suspended.

6 Front face and the whole assembly shall be rust proof and shop-primed and painted.

7 All ceiling speakers shall comply with BS7443 (Sound Systems for Emergency Purposes) and should be equipped with fire dome.

8 Ceiling speakers with volume control shall be located in areas as shown on drawings.

9 Backbox:
   (a) Poured or plaster ceiling locations:
   (b) The backbox shall be recessed round enclosure for 100mm speaker/baffle assemblies.
   (c) It shall be made of 22-gauge welded steel with a rust-inhibiting coating, and undercoated with a fire-retardant resonance damping material.
   (d) Knockouts shall be spaced at 90o.
   (e) The mounting ring shall provide 3mm holes for nailing or wiring in place.
   (f) Torsion spring receptacles.
   (g) The backbox shall be suited for mounting in poured or plaster ceilings as well as in conventional drop ceilings.
   (h) Manufacturer: Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

10 Baffle:
   (a) Baffle shall install with torsion spring hardware.
   (b) Finish shall be matte white.
   (c) The 100mm baffle shall measure approximately 190mm in diameter.
   (d) Construction shall be welded 22 ga. CRS.
   (e) Manufacturer: Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

50.2.7 Wires and cables:

1 Wires and cables shall provide sufficient resistance to the spread of fire (according to NFPA) and generate no hazardous smoke to human life. Wiring
system shall include all indoor and outdoor wires and cables necessary for complete PA system. Including control and supervisory circuits, interconnecting with other related systems (FA, FI, etc.).

2 The system wiring shall be Redundant Loop that single failures don not proper functioning of the system.

3 Wiring shall be in accordance with local, state and national codes (e.g., NFPA 70 and NFPA 72 -NEC –Article 760) and as recommended by the manufacturer of the PA system. Number and size of conductors shall be as recommended by the PA system manufacturer.

4 PA Circuit Integrity (CI) Cable should ensure continued operation of circuits during a specified time under fire conditions.

5 The public address wiring shall include the following:

6 Public address wiring, which connects loudspeakers with the public address equipment.

(a) Analog and digital wiring which connects the public address systems with the LAN boxes.

(b) Wiring which connects microphone stations with the PA systems.

(c) Wiring which connects Noise Dependent AVC with PA systems.

(d) Conductors: conductor Size of speaker circuits shall not be smaller than 2 mm (according to the approved calculations base on the power handling and the allowed loss).

(e) Use jacketed twisted-pair untinned solid copper conductors. In all conditions voltage and power loss in wiring shall not exceed three percent (3%).

(f) Low Signal Wiring: Analog and digital low signal wiring shall be twisted shielded of appropriate characteristics to meet the Manufacturer standards.

(g) Insulation for Wire in Conduits: Thermoplastic not less than 0.2 mm thick.

(h) Shielding: Tinned soft copper strands formed into a braid or approved equivalent foil type.

(i) Low Signal Cables: Neoprene jacketed not less than 0.2 mm thick over shield with filled interstices.

(j) Exposed Wiring: Where wiring is not to be in metal raceway conduit, use paired cables with plastic jackets. Where such cable will be installed in air plenums or plenum ceilings, provide cable UL approved for plenum installation.

(k) Weatherproof Equipment: Where equipment is to be weatherproof or is exposed to weather, provide items specifically designed and listed for such conditions.

50.2.8 Equipment Cabinets

1 19-inch cabinets shall be provided with the following equipment:

(a) A pair of 19 inch front uprights set back 100 mm from front face.
(b) 42U 600 x 600 mm structure.
(c) Twin vertical cable management system for front side of the rack, extending to the full height of the rack including trim plates.
(d) Removable and lockable side panels.
(e) Roof blanking plate with ventilation and 300 x 50 mm cable hole as a minimum.
(f) A pair of 300 mm basket trays for cable fixing.
(g) Earth bus bar.

50.3 EXECUTION

50.3.1 Examination

1 The Employer assumes no responsibility or liability for transportation from country of origin, storage fees, drayage, import taxes, duty taxes, or other costs associated with the delivery and storage of system components.

2 Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the Employer.

3 Contractor shall store products in accordance with manufacturer's instructions, within Contractor's staging area and with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

4 Contractor shall provide coverings to protect products from damage from traffic and construction operations, remove when no longer needed.

5 Contractor shall ensure that all work performed under these Specifications is in accordance with the requirements and standards defined and referenced in these Specifications. Any work performed in deviation of these Specifications, any of the referenced material, or any applicable standards or requirements, shall immediately be corrected by the Contractor without additional charges, regardless of the stage of completion. The Contractor shall record all inspection observations. As a minimum, the record shall include the name(s) of personnel conducting the inspection, a brief description of the inspection and the observations. These records shall be available for the Engineer to review at any time. Also, these records shall be delivered to the Engineer before final acceptance.

6 Installation Inspections: Installation inspections shall be undertaken through the performance of pre-installation, in-progress, and final inspections as follows:

7 Pre-Installation Inspection: The Contractor shall make an inspection of all equipment and material to be used prior to installation. All items shall be verified for compliance with the requirements of these Specifications and all other applicable standards. All equipment, cable, and associated hardware identified for installation shall be inspected for damage and completeness utilizing standard practices to determine integrity and acceptability.

8 In-Progress Inspection: At the Engineer's discretion, the Contractor shall perform in-progress inspections that shall include visual inspections of equipment, wiring
practices, cabling, placement of equipment, marking of cables and adherence to safety procedures. In addition, the Employer, or his representative, may conduct additional inspections any time.

9 Final Inspection: The Contractor shall conduct a final inspection that encompasses all portions of the installation. This inspection shall be performed to ensure that all aspects of the installation have been performed in accordance with these Specifications, standard industry practices and the publications referenced herein. All non-compliance items shall be noted by the Contractor during this inspection. The Engineer shall witness this inspection.

10 Corrective Action and Verification Inspection: The Contractor shall perform all corrective actions to ensure that all non-compliance items identified during the final inspection have been corrected.

50.3.2 Installation

1 Standards: All installation activities shall be performed in a neat and professional manner in accordance with all applicable local and national codes. Additionally, the Contractor and all subsequent Sub-Contractors employed to satisfy the requirements of these specifications shall obtain, or satisfy, the following prior to installation:

(a) All licenses and permits
(b) All insurance and bonding as required
(c) All other standards or requirements specified in this document
(d) Contractor shall install and inspect all hardware required in this specification in accordance with the manufacturer's installation instructions.

2 Contractor shall adhere to the following during installation of the system:

(a) Underwriter’s Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electric Code for customer premise installations.
(b) Fire resistance requirements specified by Underwriter’s Laboratories in UL 1459, 2nd edition.

3 Where undefined by codes and standards, Contractor shall apply a safety factor of at least two (2) times the rated load to all fastenings and supports of system components.

4 Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer’s instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

5 Rack Mounted Equipment:

(a) As a general practice, Contractor shall run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the rear.
(b) The Contractor shall run other cables on the right side of an equipment
rack, as viewed from the rear.

(c) For equipment mounted in drawers or on slides, provide the rack accessories as well as interconnecting cables with a service loop of not less than three feet and ensure that the cable is long enough to allow full extension of drawer or slide.

(d) Public address rack shall be located in main IDF room.

6 Contractor shall install all custom and packaged software in the development and production environments’.

7 Contractor shall provide a migration plan for all new and updated software to be migrated from within the development environment to the production environment.

8 Final hardware selected and installation of hardware shall be submitted for review by the Engineer. Additionally, the Contractor shall review the cabinets and equipment room to ensure ventilation requirements are met or recommend modifications.

9 Contractor shall install and configure all software required in this Specification in accordance with the software manufacturer's installation instructions. Apply the latest patches and security updates. Register the application with the manufacturer under the Employer’s name.

10 The contractor shall facilitate, configure, document and test all network connections required by other systems or other facilities not in contract that require access to the network specified herein.

11 Contractor shall place materials only in those locations that have been previously authorized. Any other locations shall be authorized, in writing, by the Engineer.

12 Contractor shall provide all tools, applications and test equipment required to install, verify, and test the installation and to determine that it meets the specifications. The Contractor shall furnish all necessary materials required to implement and to achieve the required work performance.

13 Match input and output impedances and signal levels at signal interfaces.

14 Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings. Adjust for actual ambient noise.

15 Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

16 Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

50.3.3 Documentation

1 This Part requires complete documentation of all systems for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to
the troubleshooting, identification, and repair of defective parts. All documentation, as described herein shall be submitted to the Engineer for approval sixty (60) days prior to final submission.

2 Scope: The Contractor shall provide the Employer with Operation and Maintenance Manuals and other documentation on all installed systems. These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.

3 The maintenance manual requirement of this Part is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing, and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.

4 Maintenance Manuals, Manufacturer's Literature: Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.

5 Drawing Books: All Drawings developed specifically for this Project shall be reduced to half-size, folded and bound with hard plastic covers. The half-size Drawings provided shall be easily readable after printing, even if this requires breaking large Drawings into several parts. Text shall be no smaller than 2 mm. The drawing book documents shall be produced with current version of AutoCAD and the electronic files shall be provided to the Employer at the completion of the Project on DVD/CD-ROM. Provide component identification and cross reference on the Drawings to allow the maintenance department to understand the function of each item (the block diagram), find the room where the device is mounted (Contract Document plans), find its location in a rack (Arrangement Drawings), find how it is wired (wiring diagrams), and its detailed Specifications (vendor data sheets), and how to repair it (spare part lists). Include the following drawings as a minimum:

(a) System Block Diagram: This drawings shall depict the final LAN overview, including equipment types, location, IP addresses and any special information

(b) System Riser Diagram(s): These drawings shall show all LAN components, wire numbers, color codes, pin numbers, component locations and connections, depicting the "as-built", final configuration

(c) Rack Elevation and Wiring Diagram(s): The elevation diagrams shall depict the front views of the equipment racks identifying all equipment installed within. Complete wiring diagrams of the racks shall also be included

(d) Floor plans of the communications rooms showing the location of all equipment effected as a part of this contract within the communications rooms
(e) Elevation drawings of all wall mounted equipment showing the location of each component on the wall. Components on the walls shall be identified as in the functional block diagrams.

(f) Wiring Diagrams: Provide wiring diagrams showing all field installed interconnecting wiring. Wire identification on the diagrams shall agree with the wire markers installed on the equipment.

(g) System Administrator Documentation: The Contractor shall supply three (3) hardcopies of administrator documentation and three (3) copies of the documentation in PDF format on CD-ROM that detail the operation of the system. This documentation shall provide complete information on the configuration, business rules, operation, maintenance, and trouble-shooting of the system.

6 Warranty: The Contractor shall supply all warranties as required in the “Warranty” article of this specification.

50.3.4 General Testing Requirements

1 Phases of Testing:
   (a) Factory Acceptance Testing
   (b) Integration Testing
   (c) Endurance Testing

2 Project Testing: The system installation shall not be considered complete until On-Site Endurance Testing are completed. The purpose is to test the complete system and demonstrate that all specified features and performance criteria are met. All requirements of the specification shall be tested, including:
   (a) Functionality, including reporting and response
   (b) System capacity
   (c) Hardware and software interaction
   (d) Failure Recovery
   (e) Report generation

3 Test Plan/Procedure: Contractor shall provide six (6) copies of the proposed test plan/procedures for each testing phase for the review of the Engineer. The test plan for each phase of testing shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The submission of Test Plans shall adhere to the following:
   (a) A draft test plan shall be presented to the Engineer at least forty-five (45) days prior to the scheduled start of each test
   (b) A workshop for reviewing comments shall be conducted with the Engineer at least thirty (30) days prior to the scheduled start of each test
   (c) A final test plan shall be submitted to the Engineer at least fourteen (14) days prior to the scheduled start of each test

4 Test plans shall contain at a minimum:
(a) Functional procedures including use of any test or sample data
(b) Test equipment is to be identified by manufacturer and model including LAN analyzers and packet sniffers
(c) Interconnection of test equipment and steps of operation shall be defined
(d) Expected results required to comply with specifications
(e) Traceability matrix referencing Specification requirements with specific test procedures
(f) Record of test results with witness initials or signature and date performed
(g) Pass or fail evaluation with comments

5 The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.

6 All Test plans must be reviewed by the Engineer. To successfully complete a test, the test document must be signed and dated by both the Contractor and the Engineer.

7 The Engineer will review, witness and validate the execution of all formal test procedures prepared by the Contractor and deliverable under the contract to assure the tests cover all requirements and that there is a conformity between the conducted test, the test results and Specification requirements.

8 Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.

9 The Contractor shall provide the Employer or Employer representative the opportunity(s) to participate in any or all of tests.

10 Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Six (6) copies of the test report shall be submitted to the Employer representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:

(a) Commentary on test results
(b) A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution
(c) Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test
(d) Signatures of persons who performed and witnessed the test

11 Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to Employer. The problems identified in each phase shall be corrected and the percentage of the entire system re-tested determined by the Engineer before any subsequent testing phase is performed.
12 Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

(a) Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.

(b) Repeat test for each separately controlled zone of loudspeakers.

(c) Minimum acceptance ratio is 50 dB.

13 Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.

14 Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.

15 Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.

16 Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Part "Grounding and Bonding for Communication Systems."

50.3.5 Factory Acceptance Testing

1 The purpose of this test is to validate that the individual systems components function as standalone equipment and all specified features are met.

2 The Contractor shall ensure that development of the system is complete, required approvals of submittals have been obtained, and sufficient equipment has been procured to completely demonstrate and test the system.

3 Factory Acceptance testing shall be completed at an Employer authorized test site.

4 Test Setup Equipment: Equipment shall be the actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting pre-delivery test:

(a) Equipment associated with the system
(b) Devices associated with system
(c) Software associated with system
(d) Administrative tools and equipment
(e) Sufficient data to provide accurate simulation of all potential permutations
of operational conditions as required by design

5 Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer authorized personnel.

6 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

7 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

8 Reporting:
   (a) Record all test procedures and results
   (b) Submit report in accordance with reporting requirements in General Testing Requirements Section.

50.3.6 Integration Testing

1 The purpose of this test is to validate integration between the system and other interfaced subsystems or systems and to demonstrate that all specified features are met. All requirements of the LAN integration shall be tested including connectivity, interaction, interface, format, and data flow.

2 Integration testing shall be completed at the systems integration laboratory or other authorized location on-site at the campus. Interfaces may be tested using simulated data to/from other systems.

3 Test Setup Equipment: Equipment shall be actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting the test:
   (a) Equipment associated with the system
   (b) Devices associated with system
   (c) Software associated with system
   (d) Administrative tools and equipment
   (e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

4 Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer personnel.

5 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

6 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

7 Reporting:
(a) Record all test procedures and results
(b) Submit report in accordance with reporting requirements in General Testing Requirements Part

50.3.7 Endurance Testing

1 The purpose of this test is to validate that the fully integrated system meets the Endurance and High Availability requirements.

2 Integration testing shall be completed on-site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor. All interfaces shall be tested using actual interfaces to other systems (i.e. no stubs or dummy data.)

3 Requirements:

(a) Provide personnel to monitor system operations 24 hours per day, including weekends and holidays during Endurance Testing
(b) Start test after:
   (i) Successful completion of Integration Testing
   (ii) Training as specified has been completed
   (iii) Correction of deficiencies has been completed
   (iv) Receipt of written start notification from the Engineer
(c) Monitor all systems during Endurance Testing. Coordinate monitoring with the Engineer
(d) Recording: Record data on forms so as to provide a continuous log of systems performance. Include:
   (i) Date and time for all entries
   (ii) Name of individual making entry
   (iii) Environmental conditions
   (iv) Activities in process
   (v) Description of all alarms, responses, corrective actions, and causes of alarms. Classify as to type of alarm
   (vi) Description of all equipment failures, including software errors
   (vii) Description of all maintenance and adjustment operations performed on system
   (viii) Daily and weekly tabulations
   (ix) Daily entries of performance data shall be reviewed by the Engineer
(e) Employer may terminate testing at any time when the system fails to perform as specified. Upon termination of testing the Contractor shall commence an assessment period as described in Stage II

4 Testing

(a) Stage I - Initial Phase Testing:
(i) Time: 24 hours per day for 30 consecutive calendar days
(ii) Make no repairs during this stage unless authorized in writing by the Engineer
(iii) If system experiences no failures, proceed to Stage III - Final Testing

(b) Stage II - Initial Phase Assessment:

(i) After conclusion of Stage I, or terminating of testing, identify all failures, determine causes, and repair. Submit report explaining: Nature of each failure, corrective action taken, results of tests performed to verify corrective action as being successful, and recommended point for resumption of testing
(ii) After submission of report, schedule review meeting at job site. Schedule date and time with the Engineer
(iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
(iv) Based on report and review meeting, the Engineer will direct Contractor to repeat Stage I, restart Stage I, or proceed to Stage III - Final Testing

(c) Stage III - Final Phase Testing:

(i) Time: 24 hours per day for 15 consecutive calendar days
(ii) Make no repairs during this stage unless authorized in writing by the Engineer

(d) Stage IV - Final Phase Assessment:

(i) After conclusion of Stage III or termination of testing, identify all failures, determine causes, and repair. Submit explaining the nature of each failure, corrective action taken, results of tests performed, and recommended point for resumption of testing
(ii) After submission of report schedule review meeting at job site. Schedule date and time with the Engineer
(iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
(iv) Based on report and review meeting, the Engineer will review Endurance Test or direct Contractor to repeat all or part of Stages III and IV

5 Adjustment, Correction, and Maintenance

(a) Adjustment and Correction: Make adjustments and corrections to system only after obtaining written approval of the Engineer
(b) Maintenance: Perform required maintenance on systems including provision of replacement parts

6 Final Inspection and Acceptance

(a) After Endurance Testing is complete, review tabulated records with the Engineer
(b) Contractor will not be responsible for failures caused by:
(i) Outage of main power in excess of backup power capability provided that automatic initiation of all backup sources was accomplished and automatic shutdowns and restarts of systems performed as specified

(ii) Failure of any Employer furnished power, communications, and control circuits provided failure not due to Contractor furnished equipment, installation, or software

(iii) Failure of existing Employer equipment provided failure not due to Contractor furnished equipment, installation, or software

(c) When performance of system does not fall within the above parameters, determine cause of deficiencies, correct, and retest

(d) When requested by the Employer, extend monitoring period for a time as designated by the Employer

(e) Period shall not exceed 60 days exclusive of retesting periods caused by termination of Stages I or III and assessment period of Stages II and IV

(f) Submit final report of Endurance Testing containing all recorded data

50.3.8 Maintenance And Support

1 General

(a) The Contractor shall provide maintenance and support of all components associated with this system at no additional charge during the warranty period. This extends to systems requiring vendor pre-purchased maintenance agreements.

(b) The Contractor shall supply a list of special tools, test equipment, and outside inventory required for this Project. The Contractor may recommend specific items to facilitate long-term support of the system as an option to the Employer.

(c) All lead technicians performing installation and maintenance shall have a minimum of two (2) years experience on the proposed system and be manufacturer certified on all hardware/software applications. All maintenance technicians shall be provisioned to attend a one (1) week manufacturer training class each year. Pre-assigned backup technicians shall be available to backfill for onsite technicians who are on vacation, in training or who are out sick

(d) The Contractor shall provide twenty-four (24) hours/seven (7) days a week telephone support as a minimum maintenance and support agreement. Additionally, the Contractor shall specify a maximum amount of time to get the system up and operational in the event of a system failure. This time period shall be subject to Engineer’s approval

2 Hardware and Software Support

(a) Hardware and Software support shall be supplied by the Contractor directly or by a Sub-Contractor reviewed by the Employer. Support shall cover all

(b) The Contractor shall assume full responsibility for the performance of all equipment supplied by the Employer, provided that such equipment meets the specifications set forth by the Contractor
(c) All software shall be delivered with an installable backup

3 Pricing after Warranty Period: Cost of maintenance and support on a yearly basis after the Warranty period has expired, shall be included as an option to be exercised by the Employer or his designated representative. Contractor shall clearly state in the bid the annual cost and availability of the following services that the Employer may wish to use or to continue after the initial Warranty period has expired (Costs shall be given for a three (3) years with additional two (2) years to be renewed on an annual basis):

(a) Costs of maintenance of the equipment and software
(b) Cost of software and firmware upgrades
(c) Telephone consultation support
(d) Technicians on-site (including travel, meals and lodging) to repair or replace malfunctioning equipment or software, if not covered in the maintenance costs above
(e) Programming on message text, animation sequences, and the like for Employer use and operation

4 Definitions

(a) Preventive and Routine Maintenance: Preventive and routine maintenance services shall be provided in accordance with the provisions of the maintenance manual for each component. Preventative maintenance services shall include inspection, test, necessary adjustment, lubrication, parts cleaning, and upgrades. Routine maintenance services shall include scheduled overhauls as recommended by the equipment manufacturer

(b) Emergency Failure: A system failure is considered an emergency if any of the key components are inoperative to the extent the system cannot function in a normal manner. Emergency services shall include inspections and necessary tests to determine the causes of equipment or software malfunction or failure. The emergency services shall include furnishing and installing components, parts, or software changes required to replace malfunctioning system elements. The Contractor shall provide telephone support twenty-four (24) hours a day, seven (7) days a week. The Contractor shall provide support on-site within eight (8) hours of request.

(c) Support: Support shall be supplied by the Contractor directly or by a sub-Contractor reviewed by the Employer. Support shall cover all equipment referenced in this specification

50.3.9 Cleaning

1 Upon completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

50.3.10 Training

1 The User Training shall include on-the-job-training of at least two (2) weeks. The training shall be conducted on site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Snim, Al Khor and Al Mashaf.
2 The System Administrators Training shall include on-the-job training. Six (6) weeks of on-the-job training shall be provided. This training shall be conducted on site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Snim and Al Khor.

3 The Contractor shall provide the Employer specified trainees with detailed As-built information by the Contractor Lead Network Engineer. The training shall provide the system Administrators with a working knowledge of the system design and layout, and shall provide troubleshooting methods and techniques. In addition, the training shall cover testing, maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.

4 Course materials shall be delivered to the Employer. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the Employer. The Contractor shall supply a videotape of each training course.

5 All training shall be completed a minimum of two (2) weeks prior to the system becoming operational and utilized by the Employer. Training schedule subject to the Employer’s review.

50.3.11 Acceptance

1 The Contractor shall not apply power to the system until after:

   (a) System and components have been installed and inspected in accordance with the manufacturer's installation instructions

   (b) A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections

   (c) System wiring has been tested and verified as correctly connected as indicated

   (d) All system grounding and transient protection systems have been verified as properly installed and connected, as indicated

   (e) Power supplies to be connected to the system and equipment have been verified as the correct voltage, phasing, and frequency as indicated

2 Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3 Acceptance will be withheld until the following have been completed successfully:

   (a) Acceptance of all submittals

   (b) Successful testing and delivery of approved test results

   (c) Completed Training as per the specifications as well as successful demonstration of the operation of the entire system

   (d) Final cleanup of the system and work areas

   Delivery of all documentation including accepted As-built documentation.
Add the following completely new Part titled: Part 51 – Master Antenna Television including its new clauses as follows:

51. MASTER ANTENNA TELEVISION

51.1 GENERAL

51.1.1 Summary

1 Drawings and general provisions of the Contract, including Terms of Reference and all contractual conditions apply to this Part.

2 All Specifications listed in this specification shall be used as functional performance-based specifications. The Contractor shall be responsible for completing and coordinating requirements necessary to design, furnish and install fully engineered and functional systems. These requirements include any site analysis, furthering of design documents, determination of quantities of equipment, verification of existing conditions and external service providers, and the like. It shall be the responsibility of the Contractor to provide any additional equipment, software, arrangements or infrastructure necessary to complete the system commissioning.

3 This Section includes the general requirements of a Master Antenna Television (MATV) system including antennas, head end switchers and distribution network. The signal source of the system consists of:

   (a) A satellite earth-station system of the receive only type (for the reception of digital and analogue satellite programs).

   (b) An off-air antenna system (for the reception of terrestrial programs).

4 The MATV system final design and construction shall comply with the design intent as well as specifications listed herein and associated drawings.

51.1.2 References

1 The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

2 Specific reference in Specifications to codes, rules regulations, standards, manufacturer’s instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at date of Contract unless the Document is shown dated.

3 Comply with all local codes and requirements of Authorities Having Jurisdiction (AHJ).

4 References:

   (a) EN 50083 series "Cable Networks for Television Signals, Sound Signals and Interactive Services".

   (b) EN 50117 series "Coaxial Cables Used in Cabled Distribution Networks".

   (c) ASTM: American Society for Testing Materials
(d) ANSI: American National Standards Institute
(e) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.
(f) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.
(g) IEC 60331 Part 11& 12, Tests for Electric Cables under Fire Conditions.
(h) IEC 60332 Tests on Electric Cables under Fire Conditions.
(i) IEC 60364-1 Electrical Installations of Buildings, Fundamental Principles, Assessment of General Characteristics, Definitions.
(j) Institute of Electrical & Electronics Engineers (IEEE).
(k) Building Industry Consulting Service International (BICSI).
(l) Federal Communications Commission (FCC) regulations and standards.
(m) IBC: International Building Code 2006
(n) ISO: International Organization for Standardization
(o) NFPA: National Fire Protection Association
   (i) NFPA 70 (2008)
   (ii) NFPA 72 (2010)
   (iii) NFPA 101 (2009 ed.)
   (iv) NFPA 780 (2008)
   (v) NFPA 5000 (2006 ed.)
(p) NEMA: National Electrical Manufacturers Association (NEMA)
(q) NESC: National Electrical Safety Code
(r) UL: Underwriters Laboratories
   (i) UL 83 Thermoplastic Insulated Wire and Cables
   (ii) UL 96 Lightning Protection Components
   (iii) UL96A Installation Requirements for Lightning Protection Systems
   (iv) UL 467 Grounding and Bonding Equipment
   (v) UL 497 Protectors for Paired-Conductor Communication Circuits
(s) OSHA: Occupational Safety and Health Agency
(t) Local/National Electrical codes.
(u) Local/National Health & Safety codes.
(v) Local and national regulations and codes in effect as of date of purchase.

5 All Local Codes shall prevail. Where local Codes are silent, National Codes and Standards shall be applied. Codes, rules, regulations, and ordinances governing the work, are as fully part of the Specifications as if herein repeated or attached. If the Contractor should note items in the drawings or the specifications,
construction of which would be code violations, promptly call them to the attention of the Engineer in writing.

6 Design and Install cabling in accordance with the most recent edition of Building Industry Consulting Services International (BICSI®) publications.

7 Conflicts: Where the requirements of the specifications conflict with other documents the following shall apply:

(a) Between Plans and Specifications, between different specifications, or between different plans: Comply with the one establishing the more stringent requirement.

(b) Between referenced requirements or between industry standards: Comply with the one establishing the more stringent requirements.

(c) Between referenced requirements and Contract documents: Comply with the one establishing the more stringent requirements.

51.1.3 Related Parts

51.1.4 Definitions

1 Broadband: Any system able to deliver multiple channels and/or services to its users or subscribers. For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying the frequency range of 47 to 2400 MHz. A broadband communication system can simultaneously accommodate cable television and broadcast television technologies.

2 Carrier: An alternating-current wave of constant frequency, phase and amplitude. By varying the frequency, phase or amplitude of a carrier wave, information is transmitted.

3 CSO: Composite Second Order non-linear distortion

4 CTB: Composite Triple Beat non-linear distortion.

5 dBµV: Decibels relative to 1µV across 75 ohms. Zero dBµV is defined as 1µV across 75 ohms. dBµV = 20 log10(V1/V2) where V1 is the measurement of voltage at a point having identical impedance to V2 (1µV across 75 ohms).

6 MATV: Master antenna television; a small television antenna distribution system usually restricted to one or two buildings.

7 RF: Radio frequency.

8 SAT IF: (1st) Satellite Intermediate Frequency.

9 User interfaces are the 75-ohm terminals on device plates (system TV outlets).

10 IF: Intermediate Frequency.

11 Multiswitch: A satellite distribution device, also known as Switching Matrix, that allows the end-user (subscriber) to switch over between input signals from two or more satellites in multi-feed systems.
12 DiSEqC: Digital Satellite Equipment Control: an open and unlicensed industrial satellite reception communication standard available to anyone and coordinated by EUTELSAT. Information is exchanged between satellite reception devices interconnected by standard coaxial cable by means of a modulated 22 kHz tone. DiSEqC provides the MATV end-user with control over satellite reception based on various switching criteria such as polarization levels, frequency range, etc. DiSEqC is a trademark of EUTELSAT.

51.1.5 Scope of Work

1 The Contractor shall provide, based on these specifications and schematic design drawings, the final design and construction documents and all equipment, material, labor and services required to construct and install the MATV system including, but not limited to:

(a) All design services, drawing and specifications, equipment, materials, labor and services, not specifically mentioned or shown, which may be necessary to complete the design and installation of the MATV system.

(b) Hardware including signal-source components, signal-processing and amplifying equipment, distribution components, and interconnecting wiring, as specified for the system and any hardware that is specific to the manufacturer submitted system. System shall receive signals from sources, amplify and process them, and distribute them to outlets for receiving sets.

(c) Software application and any other software that may be required to make the system fully operational as specified.

(d) Installation and setup of the system hardware and software.

(e) Final connection of hardware to power, infrastructure termination and patch cords connecting system equipment to the outlets and other communication equipment.

(f) Specifications and As-built documentation for all MATV system hardware and software components.

(g) Test plans, system testing and commissioning.

(h) System warranty as specified herein.

(i) Training as specified herein.

(j) Maintenance and support as specified herein.

51.1.6 Qualifications

1 Project Qualifications

(a) The Contractor must currently be and have been in the business of selling, installing, and maintaining similar systems at large healthcare facilities for a minimum of five (5) years. The Contractor must have been actively engaged in designing, installing, maintaining and operating similar systems and services as outlined in this document.

(b) The Contractor must have a minimum of three (3) sites that are actively using the same or similar solutions, and each of those solutions must be currently in operation, and have been in operation for at least the preceding twelve (12) months.
(c) The Contractor is required to submit information regarding a minimum of three (3) reference sites that are actively using the same or similar systems. The sites should be similar in terms of number of equipment, devices throughput, and network operations. This reference information shall include the contact name, address, telephone number, and date of original installation for each reference site listed. Additionally, for each reference site detail the features that make it a qualified site (e.g., final system acceptance date, number of devices, etc.).

2 A same or similar solution shall satisfy all the following conditions:

(a) Utilizing GPS-based stratum 1 time source
(b) Utilizing Network Timing Protocol for TCP/IP time synchronization

3 Organization Qualifications

(a) The Contractor shall provide a complete description of organizations and/or firms involved including:
   (i) Involvement of subcontractors or product vendors
   (ii) The name of the Team Leader responsible for the project coordination, development and ongoing Implementation
   (iii) Detailed description of the team and organization chart noting its structure
   (iv) Résumés for key personnel
   (v) Specific role definition including provision for leadership, technical control, teamwork, partnering, coordination and communication
   (vi) Percentage of time committed for the project by each key personnel
   (vii) Mobilization plans for the different phases of the project
   (viii) Listing of all current projects where there is an overlap or potential for overlap of manpower resources. For these projects provide a detailed description of the role, committed level of effort, schedule and completion date for each key individual of the proposed team.

(b) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

51.1.7 Submittals

1 Proposal Submittals:

(a) In addition to all required proposal submittals listed in the appropriate Division, the Contractor shall provide the following submittals:
   (i) Design Approach: In designing the systems, it is desired to standardize hardware, operating systems, etc. in order to facilitate long-term maintenance of the systems. However, the Contractor may propose an alternative solution to any of the design requirements. These alternatives shall be clearly delineated and shall be bid as options, in addition to the base design. Preference shall be given to vendor solutions which best integrate into the overall system design.
(ii) References: The Contractor is required to submit data sheets for same or similar implementations as specified in the “Qualifications” article of this specification.

(iii) Qualifications: The Contractor shall supply qualification data sheets for firms and persons as specified in the “Qualifications” article of this specification to demonstrate their capabilities and experience.

2 Contract Submittals:

(a) Work Plan and Schedule: The Contractor shall supply a schedule of proposed installation and implementation, including dates and milestones within 30 days of contract award. Updates shall be submitted monthly.

(b) Proposed product data sheets: The Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification Part reference for each product. Product data sheets shall be bound in a three ring binder and shall include a product index listing the model number and description of product.

(c) Samples: Submit one sample of the product components and if required a complete assembly.

(d) System Block Diagram: The Contractor shall supply a block diagram that depicts the final system design, including riser diagrams, logical flow, single line diagrams, databases, application servers, communication and distribution methods, and external interfaces.

(e) Configuration: Submit complete lists of all proposed configuration setups, business rules, process flows, and processes implemented in the system. Lists must be submitted weekly during the project and thirty (30) days prior to any formal testing.

(f) Parts Lists: The Contractor shall supply complete Systems parts lists and breakdowns that identify each component (to the lowest repairable unit) as well as ordering information for these parts shall be provided. The characteristics of each component shall also be shown, where applicable, to aid in obtaining substitute parts. Schematics and parts layout drawings to the component level are to be provided when available. The Contractor shall supply a complete list and cross-reference of all supplied documents (i.e., name, brief description, and document number).

(g) Test Plans, Test Procedures and Test Reports: Indicate testing methods, devices, and procedures. Progress payments shall depend on the successful completion of testing and documentation. Provide the test plan at least forty five (45) days prior to the scheduled start of the first test. The test plan shall detail the objectives of all tests and samples of all proposed test forms.

(h) Manufacturers’ system manuals for each system/component provided under the referenced specification Part, including:

(i) Design and Installation.

(ii) Operation/System Administration.

(iii) Maintenance and Service.
(iv) End-user.

(i) Training Plan: Indicate proposed training methods as specified in the “Training” Part of this specification.

(j) Progress Schedule – Contractor shall submit to Project Engineer estimated construction progress schedules for the Work.

(k) Compliance Matrix: Contractor shall submit a compliance matrix that summarizes compliance or non-compliance with each specification component.

3 Supply all documents necessary to enable users to operate all systems and to change feature assignments and software parameters without assistance from the Contractor. This includes a complete listing of all software parameters of the system.

4 Record Drawings: Furnish hardcopy and electronic drawings, in AutoCAD latest format, of completed work including labeling, where applicable.

5 Show fabrication and installation details for television system equipment.

(a) Include plans, elevations, sections, details, and attachments to other work.

(b) For coaxial cable, include the following installation data for each type used:

(i) Nominal outer diameter.

(ii) Minimum bending radius.

(iii) Maximum pulling tension.

(c) Functional Block Diagram: Show single-line interconnections between components for headend and distribution system to user-interface points. Show cable types and sizes.

(d) Dimensioned plan and elevations of headend equipment. Show access and workspace requirements.

(e) Wiring Diagrams: Power, signal and grounding installations.

(f) Design Calculations: Calculate signal attenuation budget and show calculated line and equipment losses for the system based on the functional block diagram, to show that proposed system layout can be expected to perform up to specification. Calculate signal strength from sources to headend input points for each antenna. Allowable losses between components and User Interface shall be used to determine size and type of coaxial cable.

51.1.8 Warranty

1 General:

(a) The Contractor shall warrant complete installation of the equipment, system, and software to be free from defects in materials and workmanship for a period of no less than twenty-four (24) months, starting with the date of Substantial Completion. As an option, the Contractor shall supply pricing for an extended Warranty of the system. This option shall be renewable on a yearly basis, and pricing shall be supplied for a minimum of five (5) years
from the expiration of the initial Warranty.

2 Hardware Warranty:

(a) The Contractor shall warrant that the proposed hardware equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. This Warranty shall be in addition to any standard Warranty or service guarantee given by the Contractor to the Employer.

(b) The Warranty shall allow for replacement or repair of failed systems, equipment and components.

(c) The hardware warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(d) All hardware installed without an on-site spare shall have a twenty-four (24) hour repair/replacement Warranty from the time the Contractor is notified of the hardware failure.

3 Software Warranty:

(a) The warranty shall allow for replacement or repair of failed components. All software necessary to compile, modify, and maintain software supplied for this specification shall be included in this warranty.

(b) The software warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.

(c) The warranties shall include the price of all software upgrades and computer operating system upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

51.1.9 Quality Assurance

1 General: In addition to the general requirements, the Contractor must have been in the business of selling and installing similar systems for a minimum of five (5) years. The Contractor shall have been actively engaged in installing, maintaining and operating similar systems and services as outlined in the Related Parts portion of this document. The Contractor shall include eighty (80) hours of on-site assistance (excluding travel time) to be used after the final acceptance of the system. This assistance time is in addition to Warranty services and shall be performed on an on-call basis at the Employer’s request.

(a) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

(b) The Contractor shall upgrade each software package and firmware (where applicable) used in the system to the latest version by the end of the Warranty period.

(c) The Contractor shall offer an “Optional One (1) Year Extended Warranty”
package renewable for up to five (5) years to the Employer. The Employer shall inform the Contractor of the acceptance or rejection of the first year of the package at the time of final acceptance.

(i) Installation personnel shall meet manufacturer’s training and education requirements for implementation of extended warranty program.

2 NEC Compliance: Comply with NEC as applicable to construction and installation of all system components and accessories including fire rating to all cables and enclosures as applicable.

3 UL Compliance and Labeling: Provide system components, which are UL-listed and labeled.

4 Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of that type of equipment and shall be the manufacturer’s latest standard design. Items of the same classification shall be by the same manufacturer and shall be the same series and model. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.

5 All technicians providing final wire terminations, configurations, and programming on major components shall be manufacturer certified and trained on products being installed under this project.

51.1.10 Delivery, Storage, and Handling

1 Delivery: Deliver system components properly packaged in factory-fabricated type containers. Enclose an operating impact sensor in each container that is holding sensitive electronic equipment. The impact sensor shall be capable of recording a 5G rating.

2 Handling: Handle equipment and components carefully to avoid breakage, impact, denting and scoring finishes. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

3 Equipment delivered to the job site shall be opened and inspected immediately upon arriving and compared to the approved Shop Drawing submittal and checked for defects. If the equipment is not correct, the equipment shall be returned to the manufacturer immediately and a new order for the approved equipment shall be placed at no cost to the Employer.

4 Equipment and components shall be protected from the prolonged exposure, weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Employer.
51.2 PRODUCTS

51.2.1 Manufacturer

1 Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

51.2.2 General Layout and Features

1 DESCRIPTION: System equipment shall comprise signal-source components, signal-processing and amplifying equipment, distribution components, and interconnecting wiring. System shall receive signals from sources, amplify and process them, and distribute them to outlets for receiving sets.

2 CHANNELS: The 20 regular channels, shall be composed of the local terrestrial VHF/UHF channels in addition to a selected set of satellite programs- all being processed to the UHF bands before distribution to user outlets.

3 CHANNELS: System shall be capable of distributing television channels as follows, according to the CCIR international TV systems B+G and PAL color coding:

   (a) Band I, VHF: channels 2 –4.
   (b) Band III VHF: channels 5 – 12.
   (c) Bands IV/V UHF: Channels 21 through 69.

4 CHANNELS: Up to 20 regular channels suitable for all audiences (local terrestrial channels, and satellite broadcast channels), shall be available at all TV outlets and shall be viewed using a standard, commercial, color-television TV set (without any extra hardware).

5 SATELLITE DISHES: three (3) satellite dishes with a 0.9m diameter shall be installed on the top of the roof to receive Ku-band signals as emitted by: ArabSat, Hotbird, Nile Sat (or other as per Owner preference), respectively.

51.2.3 GENERAL REQUIREMENTS

1 To ensure compatibility among devices, it is recommended that all hardware equipment shall be supplied by a single manufacturer.

2 All hardware requirements given are the minimum requirements. Contractor’s product shall meet or exceed these requirements. Additionally, the hardware selected shall meet the operational, functional, and performance requirements specified herein.

3 Hardware shall be ordered as close to the actual installation date for a given phase as possible. Final hardware approval and scheduled order date are at the sole discretion of the Employer.

4 Approved Equivalent Substitution: The Contractor may propose an Employer approved equivalent device. Requests for hardware substitution shall be submitted in writing and include the hardware cut sheet and the exact configuration being proposed.
5 Environmental Rating: Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, and vibration conditions encountered at the installed location. For devices located in harsh environments such as interior uncontrolled or exterior environments, the Contractor shall provide the necessary housings or enclosures to ensure proper equipment operation and performance. The equipment shall meet the following requirements based on location:

(a) Interior controlled environment: 15 to 45 degrees C dry bulb and 20 to 90 percent relative humidity, non-condensing. Communication rooms shall be considered this type of environment.
(b) Interior, uncontrolled environment: 0 to 60 degrees C dry bulb and 10 to 95 percent relative humidity, non-condensing. Baggage make-up and breakdown areas shall be considered this type of environment.
(c) Exterior environments: -5 degrees to 70 degrees C dry bulb and 5 to 100 percent relative humidity, condensing.

6 The Contractor shall provide all termination components to the MATV outlet including patch cords for a fully operational MATV system.

7 Equipment racks: Equipment located in MATV (Com) coset located on roof shall be rack mounted in standard 19-inch racks. Contractor shall provide the appropriate factory or custom rack mount adapters for all equipment installed in the equipment racks, whether specifically itemized or not. Contractor shall cover unused slots using blank panels.

8 Enclosure Accessories: Contractor is responsible for providing fans, shelves, drawers, special power wiring, ground connections, cables, connectors, appurtenances, and adapters of any kind necessary to accommodate the system installation, operation, testing, or maintenance.

9 Components: Modular plug-in, heavy-duty, industrial- or commercial-grade units.

10 Equipment: Silicon-based, solid-state, integrated circuit devices.

11 Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages of 220 V, +/-10%, 50Hz.

12 Protection: Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for the purpose.

13 Provide AC-powered equipment with integral surge suppressors.

14 RF AND VIDEO IMPEDANCE MATCHING: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.
51.2.4 Performance Requirements

1 GENERAL: Minimum acceptable distribution system performance at all user-interface points / system outlets shall be as follows:

(a) Carrier signal levels:
   (i) RF Television: 60 to 84 dBµV at 862 MHz (77 dBµV for systems distributing more than 20 channels).

(b) Maximum level difference in carrier levels at any system outlet between distributed television channels:
   (i) for AM modulated signals in the range 47-862 MHz: 12 dB.
   (ii) for AM modulated signals over any 60 MHz: 6 dB.
   (iii) for adjacent AM modulated channels: 3 dB.

(c) Minimum isolation between any two TV outlets, Television to Television (in the range 47-862 MHz): 42 dB.

(d) Minimum isolation between any two TV outlets, FM sound to FM sound: 42 dB.

(e) RF television carrier to noise ratio: 44 dB minimum.

(f) Hum modulation ratio greater or equal to 46 dB.

(g) Echo rating in any television channel at any user-interface point/system outlet, shall not exceed 6% when measured according to EN 50083-7.

2 SPECIFICATION of the maximum output levels for wideband active equipment shall be based on EN 50083-3 for a signal to noise ratio of 60 dB CTB and 60 dB CSO (for RF television signals) and 35 dB second and third order distortions (for SAT IF signals) and the given number of channels. As the number of received channels increases, the maximum allowable level decreases.

3 MATV equipment shall be DiSEqC 2.0 or higher compatible.

51.2.5 MATV Products Requirements

1 MATV ANTENNAS

(a) OFF-AIR, MAST-MOUNTED ANTENNAS: Weatherproof single-channel or broadband type, constructed of high-strength anodized aluminum and rated to survive in a 160-km/h wind, minimum. Directional, with double director array and anti-ghost reflector system, offering a gain of 13 dB or higher. Dedicated antennas for each of band III VHF, and UHF programs shall be provided. Provide adequate number to cover all local channels, without the need to rotate antennas. Provide weather-sealed connection for the coaxial fitting to antennas.

   (i) Elements: Internally dampened against such mechanical vibration as may occur in service.
   (ii) Ends of cross-arms and elements: sealed.
   (iii) Mounting and connecting hardware: corrosion-proof.
(iv) Frequency range: matched to source frequencies.
(v) AM and FM Radio antenna separate from the broadband antenna and omni-directional type with 3 dB minimum gain.

(b) SATELLITE EARTH-STATION ANTENNA: Offset parabolic comprising reflector, universal receiving system (feed system) and associated support and mast clamp

(i) Reflector: Aluminium, powder coated
(ii) Mast clamp: prefabricated hot dipped galvanized steel
(iii) Strength of structure and attachments: adequate to withstand a minimum of 160-km/h winds while supporting installed antennas
(iv) Receiving system support: hot dipped galvanized sheet steel, plastic coated
(v) Reflector color: to the approval of the Engineer
(vi) Reflector Diameter: 0.9 m
(vii) Input frequency (reception) range: Ku-Band
(viii) Gain at 10.95 GHz: > 40dBi
(ix) Half value aperture: less than 1.43 deg.
(x) Adjustment range: 5 – 45 deg. (elevation)
(xi) Offset angle: 21 deg.
(xii) Mast clamp range: 50-90 mm

(c) Satellite Earth-Station Antenna: symmetrical parabolic comprising reflector, universal receiving system (feed system) and associated support and mast clamp

(i) Reflector: Aluminium, powder coated
(ii) Mast clamp: prefabricated hot dipped galvanized steel
(iii) Strength of structure and attachments: adequate to withstand a minimum of 160-km/h winds while supporting installed antennas
(iv) Receiving system support: hot dipped galvanized sheet steel, plastic coated
(v) Reflector color: to the approval of the Engineer
(vi) Reflector Diameter: 2.4 m
(vii) Input frequency (reception) range: C-Band and Ku-Band
(viii) C-Band Gain: > 33dBi
(ix) Ku-Band Gain: > 40dBi
(x) Provide appropriate alignment accessories to lock onto the satellites.

(d) Universal Receiving System Ku-Band:

(i) Feedhorn equipped with quad (Quattro) LNB (low noise block down-converter).
(ii) Two polarization plane switching (horizontal/vertical) and 2 frequency
band switching (analogue/digital, or low/high bands) independently, using 14/18 Volts and 0-22kHz switching respectively

(iii) Linear polarization
(iv) Input frequency: 10.7-11.7 / 11.7-12.75 GHz
(v) Noise figure: 0.9 typical
(vi) Gain: >50 dB
(vii) Output frequency: 950-1950 MHz/1100-2150 MHz
(viii) Oscillator frequency: 9.75/10.6 MHz
(ix) Polarization decoupling: >23
(x) Connectors: 4 x F-sockets, 75 ohms
(xi) Housing: weatherproof
(xii) Integral protection against surge voltages.

(e) Universal Receiving System Ku-Band:

(i) Feedhorn equipped with twin LNB (low noise block down-converter)
(ii) Two polarization plane switching (horizontal/vertical) and 2 frequency band switching (analogue/digital, or low/high bands) independently, using 14/18 Volts and 0-22kHz switching respectively
(iii) Linear polarization
(iv) Input frequency: 10.7-11.7 / 11.7-12.75 GHz
(v) Noise figure: 0.9 typical
(vi) Gain: >50 dB
(vii) Output frequency: 950-1950 MHz/1100-2150 MHz
(viii) Oscillator frequency: 9.75/10.6 MHz
(ix) Polarization decoupling: >23
(x) Connectors: 2 x F-sockets, 75 ohms
(xi) Housing: weatherproof
(xii) Integral protection against surge voltages.

(f) Low-Noise Block Converter (LNB), C-Band:

(i) Reception of signals in extended C-Band frequency range: 3.4-4.2 GHz
(ii) Linear polarization
(iii) Noise figure: 20dB typical
(iv) Gain: >60 dB
(v) Output frequency: 950-1750 MHz
(vi) Oscillator frequency: 5.15 GHz
(vii) Housing: weatherproof
(viii) Integral protection against surge voltages.
2 Headend Equipment

(a) **HEADEND EQUIPMENT:** headend equipment shall allow the reception and processing of analogue and digital satellite programs as well as terrestrial TV programs. It shall be composed of a base unit metal housing with a control unit and a minimum of 16 signal processing modules expandable to house the total required number of signal processing modules to accommodate the distribution of 100 channels over the trunk line TV distribution system.

(i) The control unit shall be a central microprocessor control unit with 2 inputs and 9 (outputs per input). The control unit shall allow easy programming of the signal processing modules

(ii) The base unit shall be provided with an output amplifier and a power supply module

(iii) The base unit shall be suitable for installation in a 19" rack

(iv) Input frequency range: 950-2400 MHz

(v) Output frequency range 47-862 MHz

(vi) Input level 60-85 dBµV

(vii) Output level: maximum 104 dBµV

(viii) Power supply operating voltage 220 VAC, 50 Hz

(ix) The signal processing modules shall be used for processing of digital or analogue satellite TV channels as well as terrestrial TV channels. One module shall allow conversion of 1 or 2 channels.

(b) **PREAMPLIFIERS:** Coaxial-down-lead-broadband or single-channel type as required, inherently protected against lightning and voltage surges and enclosed in weatherproof housings. Use antenna cable for power supply from external source.

3 Diseqc Multiswitch

(a) **Diseqc Multiswitch:** The DiSEqC multiswitch shall be the basic building block in the cascadable Sat-IF system to distribute analogue and digital signals (both Sat polarities as well as low band and high band signals from two different satellites) and terrestrial signals on to many receivers.

(b) **Feed-In Multiswitch used as headend for the multiswitch 9 cable system (Switching Matrix):**

(i) 1 terrestrial input: 47-862 MHz; through-attenuation: 3-4dB; tap loss (trunk line/receiver): 15-18dB; decoupling output/output: >40dB

(ii) 8 satellite inputs: 950-2300 MHz; through-attenuation: 1-2.5dB; tap loss (trunk line/receiver): 12-18dB; decoupling output/output: >40dB; decoupling input signal: >25dB; maximum output level: 100dBuV

(iii) Switching command for selecting an input: DiSEqC signal, Tone Burst, 13/18V and 0/22kHz

(iv) Operating voltage 240VAC through built-in power supply unit

(v) Number of user outputs (subscribers): 4, 6, 8, 12 as required or shown on drawings
(vi) Cascadable with the "cascadable multiswitch" to supply a bigger number of subscribers (or users).

(c) CASCADABLE MULTISWITCH used as cascade component subsequent to the headend multiswitch for distribution to multi-subscribers (Through-Line Matrix):
   (i) 1 terrestrial input: 47-862 MHz; through-attenuation: 3-4dB; tap loss (trunk line/receiver): 15-18dB; decoupling output/output: >40dB
   (ii) 8 satellite inputs: 950-2300 MHz; through-attenuation: 1-2.5dB; tap loss (trunk line/receiver): 12-8dB; decoupling output/output: >40dB; decoupling input signal: >25dB; maximum output level: 100dBuV
   (iii) Switching command for selecting an input: DiSEqC signal, Tone Burst, 13/18V and 0/22kHz
   (iv) Requires no additional power supply
   (v) Number of user outputs (subscribers): 4, 6, 8, 12 as required or shown on drawings

(d) Amplifier for compensating attenuation losses in the cascadable multiswitches installation (Matrix Amplifier)
   (i) Accepts 9 inputs in a satellite distribution installation composed of 1 terrestrial and 8 satellite trunk lines. Each signal is individually amplified and distributed.
   (ii) provides for terrestrial signals in the range of 47-862 MHz a:
      1) gain of 16-19dB
      2) maximum output level of 95dBuV
      3) noise figure of 7
      4) decoupling > 40dB for input/ input, input/output and output/output
   (iii) provides for satellite signals in the range of 950-2300 MHz a:
      1) gain of 12-15dB
      2) maximum output level of 108dBuV
      3) noise figure of 5
      4) decoupling > 40 dB for input/ input, input/output and output/output signals
   (iv) operating voltage 220VAC through built-in power supply unit

4 Distribution Components

(a) Scope: distribution components shall include all devices used for signal processing and distribution downstream the head-end equipment. All distribution components shall be suitable for forward and return paths.

(b) Signal Taps And Other Passive Equipment: Metal-enclosed directional couplers with brass connector parts. Unused ports shall be capped with proper impedance matching devices.
   (i) Minimum shielding rate (screening factor) shall meet Class A to EN 50083-2:
1) 30-300 MHz: 85 dB.
2) 300-470 MHz: 80 dB.
3) 470-950 MHz: 75 dB.
4) 950-3000 MHz: 55 dB.

(ii) Impedance: 75 ohms for input and output terminals.

(c) Two-way tap-offs shall meet the following requirements:
(i) Through Loss (Throughpass attenuation): 1.9 dB
(ii) Tap loss (Insertion Loss): 13 dB

(d) Four-way tap-offs shall meet the following requirements:
(i) Through Loss (Throughpass attenuation): 3.8 dB
(ii) Tap loss (Insertion Loss): 14.5 dB

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Directional Loss</th>
<th>Isolation (Coupling Attenuation)</th>
<th>Return Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-47 MHz</td>
<td>26</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>47-862 MHz</td>
<td>30</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>862-2150 MHz</td>
<td>26</td>
<td>36</td>
<td>20</td>
</tr>
</tbody>
</table>

(e) Cable system power supplies: Plug-in modular construction, with surge, short circuit, and overload protection.

(f) Signal traps: Packaged filters tuned to interference frequencies encountered in Project.

(g) Terminating resistors: Enclosed units rated 0.5 W and matched for coaxial impedance.

(h) User-Interface Device (system TV outlet): Flush, IEC type outlets, designed to mimic power socket outlet, for mounting in standard outlet box, with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semi-recessed so its protrusion is flush with the plane of device plate. Feedthrough-type cable connection shall not be used.
(i) Cable Connector: IEC Type.

(ii) Wall Plates: Match materials and finish of power outlets in same space.

(iii) Type F01: for use in VIP Patient rooms and public areas with 1 outlet for TV reception in the frequency range 47-862 MHz.

(iv) Tap loss (connection loss): less than 1.5 dB.

(v) Through loss (throughpass attenuation): less than 1 dB.

(i) Other signal processing equipment: Provide other signal-path adaptation components to achieve overall system performance. House units in standard 483mm (19-inch) electronic equipment cabinet. Include the following where necessary for indicated functional requirements whether shown in system diagrams or not:

(i) filters,
(ii) broadband and single-channel amplifiers,
(iii) combiners,
(iv) modulators,
(v) demodulators,
(vi) processors,
(vii) de-scramblers,
(viii) decoders,
(ix) converters,
(x) power supply units, etc..

5 COAXIAL CABLES

(a) Cable: Coaxial cable elements have 75-ohms nominal impedance. Cables run in environmental air spaces are listed for use in plenums.

(b) MATV trunk line cable: RG-11/U; No. 14 AWG (1.63 mm diameter) copper clad steel conductor; 7.25 mm diameter cellular polyethylene insulation; 8.1 mm diameter aluminium foil; alloy braid and 9.9 mm diameter black polyethylene sheath.

(i) Shielding rate:
   1) 30-470 MHz: greater or equal to 85 dB
   2) 470-1000 MHz: greater or equal to 75 dB
   3) 1000-2150 MHz: greater or equal to 65 dB

(ii) Attenuation per 100m at 20deg. C:
   1) 50MHz: 2.4 dB
   2) 200MHz: 5.6 dB
   3) 800MHz: 12 dB

(c) MATV indoor branch cable: RG-6/U; No. 18 AWG (1.1 mm diameter) solid copper conductor; 4.8 mm diameter cellular polyethylene insulation; 5.6 mm diameter aluminium foil and copper braid and 6.8 mm diameter PVC sheath.

(i) Shielding rate:
   1) 30-470 MHz: greater or equal to 85 dB
   2) 470-1000 MHz: greater or equal to 90 dB
   3) 1000-2150 MHz: greater or equal to 75 dB

(ii) Attenuation per 100m at 20deg. C:
   1) 50MHz: 4.2 dB
   2) 200MHz: 8 dB
   3) 800MHz: 16.8 dB

(d) Cable connectors: MATV Coaxial Cable Connectors: Type F, 75 ohms.

(e) Source quality control: Cable products shall be sweep tested at the factory
before shipping at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

51.3 EXECUTION

51.3.1 Examination

1 The Employer assumes no responsibility or liability for transportation from country of origin, storage fees, drayage, import taxes, duty taxes, or other costs associated with the delivery and storage of system components.

2 Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the Employer.

3 Contractor shall store products in accordance with manufacturer's instructions, within Contractor's staging area and with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

4 Contractor shall provide coverings to protect products from damage from traffic and construction operations, remove when no longer needed.

5 Contractor shall ensure that all work performed under these Specifications is in accordance with the requirements and standards defined and referenced in these Specifications. Any work performed in deviation of these Specifications, any of the referenced material, or any applicable standards or requirements, shall immediately be corrected by the Contractor without additional charges, regardless of the stage of completion. The Contractor shall record all inspection observations. As a minimum, the record shall include the name(s) of personnel conducting the inspection, a brief description of the inspection and the observations. These records shall be available for the Engineer to review at any time. Also, these records shall be delivered to the Engineer before final acceptance.

6 Installation Inspections: Installation inspections shall be undertaken through the performance of pre-installation, in-progress, and final inspections as follows:

7 Pre-Installation Inspection: The Contractor shall make an inspection of all equipment and material to be used prior to installation. All items shall be verified for compliance with the requirements of these Specifications and all other applicable standards. All equipment, cable, and associated hardware identified for installation shall be inspected for damage and completeness utilizing standard practices to determine integrity and acceptability.

8 In-Progress Inspection: At the Engineer's discretion, the Contractor shall perform in-progress inspections that shall include visual inspections of equipment, wiring practices, cabling, placement of equipment, marking of cables and adherence to safety procedures. In addition, the Employer, or his representative, may conduct additional inspections any time.

9 Final Inspection: The Contractor shall conduct a final inspection that encompasses all portions of the installation. This inspection shall be performed to
ensure that all aspects of the installation have been performed in accordance with these Specifications, standard industry practices and the publications referenced herein. All non-compliance items shall be noted by the Contractor during this inspection. The Engineer shall witness this inspection.

10 Corrective Action and Verification Inspection: The Contractor shall perform all corrective actions to ensure that all non-compliance items identified during the final inspection have been corrected.

11 Contractor shall examine pathway elements intended for coaxial cable installation. Check raceways, cables, trays, and other elements for compliance with accessibility for installation and maintenance, and other conditions affecting installation.

12 Contractor shall examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where television equipment is to be installed.

13 Contractor shall proceed with installation only after unsatisfactory conditions have been corrected.

51.3.2 Installation

1 Standards: All installation activities shall be performed in a neat and professional manner in accordance with all applicable local and national codes. Additionally, the Contractor and all subsequent Sub-Contractors employed to satisfy the requirements of these specifications shall obtain, or satisfy, the following prior to installation:

   (a) All licenses and permits
   (b) All insurance and bonding as required
   (c) All other standards or requirements specified in this document
   (d) Contractor shall install and inspect all hardware required in this specification in accordance with the manufacturer's installation instructions.

2 Contractor shall adhere to the following during installation of the system:

   (a) Underwriter's Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electric Code for customer premise installations.
   (b) Fire resistance requirements specified by Underwriter's Laboratories in UL 1459, 2nd edition.

3 Where undefined by codes and standards, Contractor shall apply a safety factor of at least two (2) times the rated load to all fastenings and supports of system components.

4 Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

5 Rack Mounted Equipment:
6 As a general practice, Contractor shall run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the rear.

(a) The Contractor shall run other cables on the right side of an equipment rack, as viewed from the rear.

(b) For equipment mounted in drawers or on slides, provide the rack accessories as well as interconnecting cables with a service loop of not less than three feet and ensure that the cable is long enough to allow full extension of drawer or slide.

7 Contractor shall install all custom and packaged software in the development and production environments.

8 Contractor shall provide a migration plan for all new and updated software to be migrated from within the development environment to the production environment.

9 Final hardware selected and installation of hardware shall be submitted for review by the Engineer. Additionally, the Contractor shall review the cabinets and equipment room to ensure ventilation requirements are met or recommend modifications.

10 Contractor shall install and configure all software required in this Specification in accordance with the software manufacturer's installation instructions. Apply the latest patches and security updates. Register the application with the manufacturer under the Employer’s name.

11 The contractor shall facilitate, configure, document and test all network connections required by other systems or other facilities not in contract that require access to the network specified herein.

12 Contractor shall place materials only in those locations that have been previously authorized. Any other locations shall be authorized, in writing, by the Engineer.

13 Contractor shall provide all tools, applications and test equipment required to install, verify, and test the installation and to determine that it meets the specifications. The Contractor shall furnish all necessary materials required to implement and to achieve the required work performance.

14 MATV:

(a) Install signal line surge suppressors on coaxial cables entering headend equipment space.

(b) Wiring within enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

(c) Splices, taps, and terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

(d) Coaxial cable installation

(i) Cable may not be installed in same raceway with power cable.

(ii) Coaxial cable shall not be spliced except on plywood backboards in
wire closets, or in cabinets designated for the purpose.

(iii) Outdoor connections shall be installed in enclosures with an IP56. Connectors shall be corrosion resistant with properly designed O-rings to keep out moisture.

(iv) Do not use water-based cable pulling lubricants with PVC-jacketed cable.

(v) Do not exceed manufacturer’s recommended minimum bending radiiuses

(vi) Attach antenna lead-in cable to support structure at intervals not exceeding 1 m.

(vii) Pulling Cable: Do not exceed manufacturer's recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

(viii) Exposed Cable: Install parallel to building lines, follow surface contours, and support cable according to manufacturer's written instructions. Do not run adjacent and parallel to power or data cables.

(ix) Cable Support: Install supports at intervals recommended in writing by cable manufacturer. Install supports within 150 mm of connector so no weight of cable is carried by connector. Use no staples or wire ties, pull tie-wrap snug, and do not over tighten.

(x) Signal Equalization: Where system performance may be degraded in certain operating modes, revise component connections and install distribution amplifiers and attenuators as required, providing a balanced signal across the system.

(xi) Install passive circuit devices, such as splitters and attenuators, in wire closets or cabinets. Do not install attenuators as part of user-interface device outlets.

(xii) Mount headend equipment in electronic equipment cabinets recommended by manufacturer. Group related items in methodical sequence.

(xiii) Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space. Parts that require periodic service or maintenance shall be readily accessible. Headend components that require tuning adjustments shall be accessible from the front of equipment cabinets.

(xiv) Identify system components, wiring, cabling, and terminals.

51.3.3 Documentation

1 This Part requires complete documentation of all systems for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts. All documentation, as described herein shall be submitted to the Engineer for
approval sixty (60) days prior to final submission.

2 Scope: The Contractor shall provide the Employer with Operation and Maintenance Manuals and other documentation on all installed systems. These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.

3 The maintenance manual requirement of this Part is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing, and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.

4 Maintenance Manuals, Manufacturer’s Literature: Provide manufacturer’s standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.

5 Drawing Books: All Drawings developed specifically for this Project shall be reduced to half-size, folded and bound with hard plastic covers. The half-size Drawings provided shall be easily readable after printing, even if this requires breaking large Drawings into several parts. Text shall be no smaller than 2 mm. The drawing book documents shall be produced with current version of AutoCAD and the electronic files shall be provided to the Employer at the completion of the Project on DVD/CD-ROM. Provide component identification and cross reference on the Drawings to allow the maintenance department to understand the function of each item (the block diagram), find the room where the device is mounted (Contract Document plans), find its location in a rack (Arrangement Drawings), find how it is wired (wiring diagrams), and its detailed Specifications (vendor data sheets), and how to repair it (spare part lists). Include the following drawings as a minimum:

(a) System Block Diagram: This drawings shall depict the final MATV system overview, including equipment types, location and any special information.

(b) System Riser Diagram(s): These drawings shall show all MATV system components, wire numbers, color codes, pin numbers, component locations and connections, depicting the “as-built”, final configuration

(c) Rack Elevation and Wiring Diagram(s): The elevation diagrams shall depict the front views of the equipment racks identifying all equipment installed within. Complete wiring diagrams of the racks shall also be included

(d) Floor plans of the equipment rooms showing the location of all equipment effected as a part of this contract within the equipment rooms

(e) Elevation drawings of all wall mounted equipment showing the location of each component on the wall. Components on the walls shall be identified as in the functional block diagrams

(f) Wiring Diagrams: Provide wiring diagrams showing all field installed
interconnecting wiring. Wire identification on the diagrams shall agree with
the wire markers installed on the equipment

(g) System Administrator Documentation: The Contractor shall supply three (3)
hardcopies of administrator documentation and three (3) copies of the
documentation in PDF format on CD-ROM that detail the operation of the
system. This documentation shall provide complete information on the
configuration, business rules, operation, maintenance, and trouble-shooting
of the system

6 Warranty: The Contractor shall supply all warranties as required in the “Warranty”
article of this specification.

51.3.4 General Testing Requirements

1 Phases of Testing:

(a) Factory Acceptance Testing
(b) Integration Testing
(c) Endurance Testing

2 Manufacturer’s field service: Engage a factory-authorized service representative
to inspect, test, and adjust field-assembled components and equipment
installation, including connections, and to assist in field testing.

3 Project Testing: The system installation shall not be considered complete until
On-Site Endurance Testing are completed. The purpose is to test the complete
system and demonstrate that all specified features and performance criteria are
met. All requirements of the specification shall be tested, including:

(a) Functionality, including reporting and response
(b) System capacity
(c) Hardware and software interaction
(d) Failure Recovery
(e) Report generation

4 Test Plan/Procedure: Contractor shall provide six (6) copies of the proposed test
plan/procedures for each testing phase for the review of the Engineer. The test
plan for each phase of testing shall detail the objectives of all tests. The tests
shall clearly demonstrate that the system and its components fully comply with
the requirements specified herein. The submission of Test Plans shall adhere to
the following:

(a) A draft test plan shall be presented to the Engineer at least forty-five (45)
days prior to the scheduled start of each test
(b) A workshop for reviewing comments shall be conducted with the Engineer
at least thirty (30) days prior to the scheduled start of each test
(c) A final test plan shall be submitted to the Engineer at least fourteen (14)
days prior to the scheduled start of each test

5 Test plans shall contain at a minimum:
(a) Functional procedures including use of any test or sample data
(b) Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
(c) Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Replace malfunctioning or damaged items. Retest until satisfactory performance and conditions are achieved
(d) Test equipment is to be identified by manufacturer and model including diagnostic equipment required to perform system tests and measurements including function generator, impedance bridge, oscilloscope, frequency spectrum analyzer, chart recorder, digital voltmeter, dB meter and waveform monitor.
(e) Interconnection of test equipment and steps of operation shall be defined
(f) Expected results required to comply with specifications
(g) Traceability matrix referencing Specification requirements with specific test procedures
(h) Record of test results with witness initials or signature and date performed
(i) Pass or fail evaluation with comments

6 The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.

7 Distribution system acceptance tests:

(a) Field-Strength Instrument: Provide documentation of recent calibration against recognized standards.
(b) Signal Level and Picture Quality: Use a field-strength meter or spectrum analyzer, and a standard TV receiver to measure signal levels and check picture quality at random sampling of 25 percent of outlets user-interface outlets.
   (i) Test the signal strength in dBµV at 47-862 MHz.
   (ii) Television receiver shall show no evidence of cross-channel intermodulation, ghost images, or beat interference.
(c) Signal-to-Noise-Ratio Test: Use a field-strength meter to make a sequence of measurements at the output of the last distribution amplifier or of another agreed-on location in system. With system operating at normal levels, tune meter to the picture carrier frequency of each of the designated channels in turn and record the level. With signal removed and input to corresponding headend amplifier terminated at 75 ohms, measure the level of noise at same tuning settings. With meter correction factor added to last readings, differences from first set must not be less than 45 dB.

8 Qualitative and Quantitative Performance Tests: Demonstrate reception quality of color-television program transmissions at each user interface from each designated channel and source. Quality shall be equal to or superior than that obtained with performance checks specified below, using a standard, commercial, cable-ready, color-television receiver. Level and quality of signal at
each outlet and from each designated channel and source shall comply with the Specifications when tested according to EN 50083:

(a) Signal level.
(b) Broadband frequency response.
(c) Channel frequency response.
(d) Carrier-to-noise ratio.
(e) RF visual signal-to-noise ratio.
(f) Terminal isolation.
(g) Hum modulation.

9 Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.

10 The Contractor shall provide the Employer or Employer representative the opportunity(s) to participate in any or all of tests.

11 Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Six (6) copies of the test report shall be submitted to the Employer representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:

(a) Commentary on test results
(b) A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution
(c) Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test
(d) Signatures of persons who performed and witnessed the test

12 Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to Employer. The problems identified in each phase shall be corrected and the percentage of the entire system re-tested determined by the Engineer before any subsequent testing phase is performed.

51.3.5 Factory Acceptance Testing

1 The purpose of this test is to validate that the individual systems components function as standalone equipment and all specified features are met.

2 The Contractor shall ensure that development of the system is complete, required approvals of submittals have been obtained, and sufficient equipment has been procured to completely demonstrate and test the system.

3 Factory Acceptance testing shall be completed at an Employer authorized test site.
4 Test Setup Equipment: Equipment shall be the actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting pre-delivery test:

(a) Equipment associated with the system  
(b) Devices associated with system  
(c) Software associated with system  
(d) Administrative tools and equipment  
(e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

5 Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer authorized personnel.

6 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

7 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

8 Reporting:

(a) Record all test procedures and results  
(b) Submit report in accordance with reporting requirements in General Testing Requirements Section.

51.3.6 Integration Testing

1 The purpose of this test is to validate integration between the system and other interfaced subsystems or systems and to demonstrate that all specified features are met. All requirements of the MATV system integration shall be tested including connectivity, interaction, interface, format, and data flow.

2 Integration testing shall be completed at the systems integration laboratory or other authorized location on-site at the campus. Interfaces may be tested using simulated data to/from other systems.

3 Test Setup Equipment: Equipment shall be actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting the test:

(a) Equipment associated with the system  
(b) Devices associated with system  
(c) Software associated with system  
(d) Administrative tools and equipment  
(e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

4 Acceptance: Acceptance of system to perform sufficiently and provide specified
functions shall be determined by the Engineer. Testing may be witnessed by additional Employer personnel.

5 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

6 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

7 Reporting:

(a) Record all test procedures and results

(b) Submit report in accordance with reporting requirements in General Testing Requirements Part

51.3.7 Endurance Testing

1 The purpose of this test is to validate that the fully integrated system meets the Endurance and High Availability requirements.

2 Integration testing shall be completed on-site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf. All interfaces shall be tested using actual interfaces to other systems (i.e. no stubs or dummy data.)

3 Requirements:

(a) Provide personnel to monitor system operations 24 hours per day, including weekends and holidays during Endurance Testing

(b) Start test after:

(i) Successful completion of Integration Testing

(ii) Training as specified has been completed

(iii) Correction of deficiencies has been completed

(iv) Receipt of written start notification from the Engineer

(c) Monitor all systems during Endurance Testing. Coordinate monitoring with the Engineer

(d) Recording: Record data on forms so as to provide a continuous log of systems performance. Include:

(i) Date and time for all entries

(ii) Name of individual making entry

(iii) Environmental conditions

(iv) Activities in process

(v) Description of all alarms, responses, corrective actions, and causes of alarms. Classify as to type of alarm

(vi) Description of all equipment failures, including software errors

(vii) Description of all maintenance and adjustment operations performed on system

(viii) Daily and weekly tabulations
(ix) Daily entries of performance data shall be reviewed by the Engineer

(e) Employer may terminate testing at any time when the system fails to perform as specified. Upon termination of testing the Contractor shall commence an assessment period as described in Stage II

4 Testing

(a) Stage I - Initial Phase Testing:
   (i) Time: 24 hours per day for 30 consecutive calendar days
   (ii) Make no repairs during this stage unless authorized in writing by the Engineer
   (iii) If system experiences no failures, proceed to Stage III - Final Testing

(b) Stage II - Initial Phase Assessment:
   (i) After conclusion of Stage I, or terminating of testing, identify all failures, determine causes, and repair. Submit report explaining: Nature of each failure, corrective action taken, results of tests performed to verify corrective action as being successful, and recommended point for resumption of testing
   (ii) After submission of report, schedule review meeting at job site. Schedule date and time with the Engineer
   (iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
   (iv) Based on report and review meeting, the Engineer will direct Contractor to repeat Stage I, restart Stage I, or proceed to Stage III - Final Testing

(c) Stage III - Final Phase Testing:
   (i) Time: 24 hours per day for 15 consecutive calendar days
   (ii) Make no repairs during this stage unless authorized in writing by the Engineer

(d) Stage IV - Final Phase Assessment:
   (i) After conclusion of Stage III or termination of testing, identify all failures, determine causes, and repair. Submit explaining the nature of each failure, corrective action taken, results of tests performed, and recommended point for resumption of testing
   (ii) After submission of report schedule review meeting at job site. Schedule date and time with the Engineer
   (iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
   (iv) Based on report and review meeting, the Engineer will review Endurance Test or direct Contractor to repeat all or part of Stages III and IV

5 Adjustment, Correction, and Maintenance

(a) Adjustment and Correction: Make adjustments and corrections to system only after obtaining written approval of the Engineer
(b) Maintenance: Perform required maintenance on systems including provision of replacement parts

6 Final Inspection and Acceptance

(a) After Endurance Testing is complete, review tabulated records with the Engineer

(b) Contractor will not be responsible for failures caused by:

(i) Outage of main power in excess of backup power capability provided that automatic initiation of all backup sources was accomplished and automatic shutdowns and restarts of systems performed as specified

(ii) Failure of any Employer furnished power, communications, and control circuits provided failure not due to Contractor furnished equipment, installation, or software

(iii) Failure of existing Employer equipment provided failure not due to Contractor furnished equipment, installation, or software

(c) When performance of system does not fall within the above parameters, determine cause of deficiencies, correct, and retest

(d) When requested by the Employer, extend monitoring period for a time as designated by the Employer

(e) Period shall not exceed 60 days exclusive of retesting periods caused by termination of Stages I or III and assessment period of Stages II and IV

(f) Submit final report of Endurance Testing containing all recorded data

51.3.8 Maintenance and Support

1 General

(a) The Contractor shall provide maintenance and support of all components associated with this system at no additional charge during the warranty period. This extends to systems requiring vendor pre-purchased maintenance agreements.

(b) The Contractor shall supply a list of special tools, test equipment, and outside inventory required for this Project. The Contractor may recommend specific items to facilitate long-term support of the system as an option to the Employer.

(c) All lead technicians performing installation and maintenance shall have a minimum of two (2) years experience on the proposed system and be manufacturer certified on all hardwar/software applications. All maintenance technicians shall be provisioned to attend a one (1) week manufacturer training class each year. Pre-assigned backup technicians shall be available to backfill for onsite technicians who are on vacation, in training or who are out sick.

(d) The Contractor shall provide twenty-four (24) hours/seven (7) days a week telephone support as a minimum maintenance and support agreement. Additionally, the Contractor shall specify a maximum amount of time to get the system up and operational in the event of a system failure. This time period shall be subject to Engineer’s approval.
2 Hardware and Software Support

(a) Hardware and Software support shall be supplied by the Contractor directly or by a Sub-Contractor reviewed by the Employer. Support shall cover all equipment and systems referenced in this Specification.

(b) The Contractor shall assume full responsibility for the performance of all equipment supplied by the Employer, provided that such equipment meets the specifications set forth by the Contractor.

(c) All software shall be delivered with an installable backup.

3 Pricing after Warranty Period: Cost of maintenance and support on a yearly basis after the Warranty period has expired, shall be included as an option to be exercised by the Employer or his designated representative. Contractor shall clearly state in the bid the annual cost and availability of the following services that the Employer may wish to use or to continue after the initial Warranty period has expired (Costs shall be given for a three (3) years with additional two (2) years to be renewed on an annual basis):

(a) Costs of maintenance of the equipment and software
(b) Cost of software and firmware upgrades
(c) Telephone consultation support
(d) Technicians on-site (including travel, meals and lodging) to repair or replace malfunctioning equipment or software, if not covered in the maintenance costs above
(e) Programming on message text, animation sequences, and the like for Employer use and operation

4 Definitions

(a) Preventive and Routine Maintenance: Preventive and routine maintenance services shall be provided in accordance with the provisions of the maintenance manual for each component. Preventative maintenance services shall include inspection, test, necessary adjustment, lubrication, parts cleaning, and upgrades. Routine maintenance services shall include scheduled overhauls as recommended by the equipment manufacturer.

(b) Emergency Failure: A system failure is considered an emergency if any of the key components are inoperative to the extent the system cannot function in a normal manner. Emergency services shall include inspections and necessary tests to determine the causes of equipment or software malfunction or failure. The emergency services shall include furnishing and installing components, parts, or software changes required to replace malfunctioning system elements. The Contractor shall provide telephone support twenty-four (24) hours a day, seven (7) days a week. The Contractor shall provide support on-site within eight (8) hours of request.

(c) Support: Support shall be supplied by the Contractor directly or by a sub-Contractor reviewed by the Employer. Support shall cover all equipment referenced in this specification.
51.3.9 Cleaning

1 Upon completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

51.3.10 Training

1 The User Training shall include on-the-job-training of at least two (2) weeks. The training shall be conducted on site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf or other campus location provided by the Employer.

2 The System Administrators Training shall include on-the-job training. Six (6) weeks of on-the-job training shall be provided. This training shall be conducted on site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf or other campus location provided by the Employer.

3 The Contractor shall provide the Employer specified trainees with detailed As-built information by the Contractor Lead Engineer. The training shall provide the system Administrators with a working knowledge of the system design and layout, and shall provide troubleshooting methods and techniques. In addition, the training shall cover testing, troubleshooting maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.

4 The training shall also demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.

5 The training shall also demonstrate programming and tuning of satellite receivers.

6 Course materials shall be delivered to the Employer. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the Employer. The Contractor shall supply a videotape of each training course.

7 All training shall be completed a minimum of two (2) weeks prior to the system becoming operational and utilized by the Employer. Training schedule subject to the Employer’s review.

51.3.11 Acceptance

1 The Contractor shall not apply power to the system until after:

(a) System and components have been installed and inspected in accordance with the manufacturer’s installation instructions

(b) A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections

(c) System wiring has been tested and verified as correctly connected as indicated

(d) All system grounding and transient protection systems have been verified as properly installed and connected, as indicated
(e) Power supplies to be connected to the system and equipment have been verified as the correct voltage, phasing, and frequency as indicated

2 Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3 Acceptance will be withheld until the following have been completed successfully:

(a) Acceptance of all submittals
(b) Successful testing and delivery of approved test results
(c) Completed Training as per the specifications as well as successful demonstration of the operation of the entire system
(d) Final cleanup of the system and work areas
(e) Delivery of all documentation including accepted As-built documentation.
Add the following completely new Part titled: Part 53 – Queue Management System:

53. QUEUE MANAGEMENT SYSTEM

53.1 GENERAL

53.1.1 Related Documents

1. Drawings and general provisions of the Contract, including Conditions of Contract and Specification Sections, apply to this Section.

2. In particular, refer to these documents for all elements related to costs and responsibility related to delivery, storage, and roll-out phase.

3. Contractor submittal shall also fully comply with all requirements of the Employer.

4. All materials and equipment supplied by the Contractor shall be new and shall meet or exceed the latest published specification of the manufacturer in all respects.

5. All Code mandated equipment shall be UL Listed or equivalent. Likewise, unless waived in writing by the Employer, all general equipment shall also be UL listed, or equivalent.

6. The QMS Supplier/Installer shall supply the latest model, available at the time of bidding, of each piece of equipment.

53.1.2 Definitions

1. PA: Public Address System

2. QMS: Queue Management System

3. SCN: Structured Cabling Network

4. UL: Underwriters Laboratories

5. Employer throughout the specifications refers to Public Works Authority (PWA).

6. Operator throughout the specifications refers to Primary Health Care Corporation (PHCC).

53.1.3 System Description

1. The present document is to describe the Queue Management System to be installed for the 5 clinics.

2. This Section includes the following:

   (a) Queue machine ticket dispensers/kiosks with ticket printing and customization capabilities,

   (b) Display units such as LCD screens with speakers, LED screens with speakers, etc,
(c) Software with operations and management functionalities,
(d) Servers with management and reporting capabilities.
(e) All wiring, control cabling, conduit, boxes, weather- proof enclosures, contactors and accessories and ancillary work, whether described in the Specification or not, required for a complete and fully operational system.

3 Interfaced Systems with the Queue Management System (QMS)

(a) The interfaced systems with the QMS are the following and interfacing should be thoroughly coordinated as per client’s requirements:
   (i) The Structured Cabling Network System (SCN)
   (ii) The Public Address System (PA),
   (iii) The Uninterrupted Power Supply (UPS),
   (iv) The Architectural Design,
   (v) Others as deemed necessary.

4 Design Requirements

(a) Scope of Work:
   (i) The Scope of Work shall include, but not limited to, detailed engineering, fabrication and coordination thereof, supply and installation of all specified equipment, operator training, hardware, software, wiring, cabling, labor, supervision, management control, testing, commissioning, systems interfaces, maintenance and 24 month warranty for all supplied equipment.
   (ii) In addition to the above, the Contractor is also expected to supply the following:
      1) Coordination meeting with the Employer, authorities, contractors, etc.,
      2) Progress reports and Progress reviews,
      3) Insurance for the transport of the equipment,
      4) Quality assurance setup and management,
      5) Document Management,
      6) Configuration management for the duration of the project,
      7) Off-the-shelf software updates for the duration of the warranty,
      8) User documentation and training including textbooks,
      9) Worksite expenses (set up and removal of temporary offices, worksites, vehicles, site offices computers, printers, desks, etc.),
      10) Archival

(b) It is asked to provide a complete Queue Management System for Health Centers.

(c) The system shall include, but shall not limited to, the following:
(i) Thermal Ticket dispenser/ Touch screen Information kiosk for specific locations as shown on Drawings, shall provide ticket printing and customization capabilities.

(ii) Display units complete with Speakers:

1) Shall be LCD screens c/w Speakers or LED screens c/w Speakers to indicate counter displays, to provide guidance and enable a clear display of the counters and tickets being served.

2) Display units shall be customizable per clinic.

3) Announcement shall be flexible with multiple language and inputs as required by the clinic operator.

(iii) Counter keypad / counter display (seven segment display SSD – 3digit)

(iv) Queue server with monitoring, management and control system for the Queue Management System implemented for the 5 clinics installed in the main telecom room at the ground floor level with a remote monitoring terminals at the Security Room and other remote locations connected to the LAN.

1) The system shall be a modular and connectable to a Structured Cabling Network (TCP/IP) and shall include servers with management and reporting capabilities, capable of providing real-time workflow information such as quantity of patients waiting in each category, patient wait times, counter activity. The servers shall also be able to print statistical reports automatically or on-demand.

2) The system shall include software with functionalities allowing to manage counter load, transfer a ticket, allocate services and awaiting patients, prioritize patients, etc as required to allow for optimal patient flow. System should allow patient selection rules (priorities/logical sorting) to be changed from each workstation in order to optimize patient flow.

3) Equipment repair shall be possible on site by module replacement.

(v) Signal converter (RS485/RS232 to RJ45).

Customers receive numbered ticket and are seated in the waiting area. Upon hearing an audio signal accompanied by the display of his/her ticket number; the customer can proceed to the service station which will introduce the desired service.

53.1.4 Submittals

1 Product Data: For each item of queue management system equipment. Include manufacturer’s standard details and installation and maintenance instructions.

2 Shop Drawings: For each item of queue management system equipment. Include plans, elevations, and details of typical members and other components. List all components of the system, supported by catalogues and manufacturer’s
technical data. Show layout and installation details, including anchorage details and mounting methods.

3 Wiring Diagrams: Detail wiring for queue management system equipment operator, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Show locations of connections to electrical service provided in other Sections.

4 Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for equipment with factory-applied color finishes.

5 Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by Engineer.

6 Maintenance Data: For queue management system equipment components to include in the maintenance manuals.

7 Product Data

(a) Product Data: For each type of product indicated. Include operating characteristics, furnished specialties, and accessories. Reference each product to a location on Drawings.

(b) Product data submittal shall include the following, as a minimum:

(i) Schedule of equipment proposed, with catalogue reference number.

(ii) Name and address of the Manufacturer and country of origin of the product.

(iii) Compliance statement to specification, with necessary supporting documents.

(iv) Catalogue pages of proposed equipment.

(v) Basic system architecture indicating tie-in points with existing services.

(vi) Name and address of the authorized local representative/dealer.

(vii) System functional description and application.

(c) Include data on features, ratings, and performances.

8 Shop Drawings

(a) Locate devices as shown on Drawings.

(b) Layout drawings showing location of devices, cables and containment, etc.

(c) Diagrams for cable management system.

(d) System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system.

(e) Wiring Diagrams: they shall show typical wiring schematics, including typical installation details, doors hardwiring scheme, dimensions, etc.
(f) Detail system schematic for each area.

9 I. Manufacturer's Installation Instructions

(a) Provide Manufacturer's installation instructions.

10 Integration Control Document

(a) The Contractor shall supply with his submission the Integration Control Document (ICD) on which the standard protocol shall be mentioned.

11 System Operation Description

(a) Include method of operation and supervision of each component and each type of circuit, and sequence of operations for manually and automatically initiated system inputs.

(b) Description must cover this specific Project; Manufacturer's standard descriptions for generic systems are not acceptable.

12 Product Certificates

(a) The Contractor shall provide certificates signed by Manufacturers of components certifying that products furnished comply with requirements.

13 Qualification Data

(a) For firms and persons specified in "Quality Assurance" an article shall be written to explain and demonstrate their capabilities and experience.

(b) To include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by the Engineer.

14 System Operation Description: Include method of operation and supervision of each component and each type of circuit, and sequence of operations for manually and automatically initiated system inputs. Description must cover this specific Project; Manufacturer's standard descriptions for generic systems are not acceptable.

15 Tests and Certificates

(a) Submit complete certified Manufacturer's type and routine test records, in accordance with the Standards specified in "Quality Assurance" Article.

16 Field Test Reports

(a) As specified in "Field Quality Control" Article of this Section, the Contractor shall indicate and interpret test results for compliance with system description and performance requirements.

17 Record (As-Built) Drawings shall include:

(a) Complete wiring diagrams, including complete terminal strip layout and identification, and wire termination and tagging for all conductors.
(b) Locations for all components installed and/or connected to under this Specification.

18 Sample Warranty

(a) Copy of Manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.
(b) Provide copy of sub-contractor's warranty certificates.
(c) Provide Contractor warranty certificates.

19 Maintenance Data

(a) For the Queue Management System, documents shall include Emergency, Operation, and Maintenance manuals. In addition to items specified above, manuals should include, but not only, the following:

(i) System software documentation.
(ii) Server installation and operating documentation, including all installed peripherals.
(iii) Hard copies of Manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hardcopy submittal.
(iv) System installation and setup guides, with data forms to plan and record options and setup decisions.
(v) As-Built layouts and schematics.
(vi) System operation.
(vii) Maintenance schedule.
(viii) Power supply schedule.
(ix) Integration and interfaces with other systems documentations.

20 Format and Presentation of the Documents

(a) The Contractor shall establish plans to scale and diagrams as per the following presentation:

(i) Floor layout of the building and raceway will have to be on scale 1/100.
(ii) Equipment room layout will have to be on scale 1/50.
(iii) Racks and cabinet configuration, front and back view, as well as the plans of detail and service shafts, will have to be on scale 1/10.

(b) The Contractor shall give the whole set of documents in three copies on electronic (CD Rom) and paper.

(c) The documents shall be submitted in the following standard formats:

(i) Dxf format of AutoCAD (TM), most recent version, for the plans, diagrams and synoptic.
(ii) Xls format of Excel (TM), most recent version, for the tables and
schedules.

(iii) Word format (TM), most recent version, for the text documents, handbooks, etc.

(iv) Pdf format of Adobe Acrobat (TM), most recent version, for the technical data sheets and Manufactures catalogues.

53.1.5 Regulation and Standards

1 Rules

(a) The supply shall be conformed to requirements of referenced industry standards, applicable sections.

(b) The supply shall be compliant with Local Requirements, applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Engineer, in writing.

2 Standards

(a) Quality Standard for Installation shall be NFPA 70.

(b) System components, parts and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC)


(ii) ISO 14443 A or B Standard.

(iii) EIA/TIA 568, Commercial Building for Telecommunication Wiring Standard.

(iv) EIA/TIA 569, Commercial Building for Telecommunication Pathways and Spaces.

(v) EIA/TIA 606 for Telecommunications Infrastructure: This document provides the user of this document with guidelines and choices of classes of administration for maintaining telecommunications infrastructure.


(vii) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials from Cables and Test on Gases Evolved During Combustion of Electric Cables.

(viii) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.

(ix) IEC 60331 Part 11 & 12, Tests for Electric Cables under Fire Conditions.

(x) IEC 60332 Tests on Electric Cables under Fire Conditions.

(xi) IEC 60364-1 Electrical Installations of Buildings, Fundamental Principles, Assessment of General Characteristics, Definitions.

(c) Several material and test standards have been developed and published by
Institute of Electrical and Electronics Engineers (IEEE) for data communications industry, focusing on local area networks (LAN):

802.1 - Network Management Group.
802.2 - Logical Link Control Group.
802.3 - Carrier Sense Multiple Access/Collision Detection Group.
802.6 - Metropolitan Area Networking Group.
802.7 - Broadband Technical Advisory Group.
802.8 - Optic Fiber Technical Advisory Group.
802.9 - Integrated Voice and Data LAN Working Group.
802.11 - Wireless Networks.
802.12 - Fast Ethernet.

(d) ISO: International Standardization Organization:
(i) It promotes the development of international standardization with scientific, technological and economic activities.
(ii) The Technical Committee 97, Information Processing, developed a seven-layer communications reference model that allows multiple protocol and multiple vendor environments to interconnect and operate with one another.

(e) Comply, as often as possible, with both ITU-T (International Telecommunications Union) recommendations and US standards. When standards are not compatible in both Europe and US (e.g. telecom interfaces SDH STMx vs. SONET OCx) detailed compatibility and interface availability shall be provided.

(f) National Electrical Code (NEC):
(i) Many local building codes are based on the NEC and are a must for those responsible for providing a safe implementation of a communication system. Articles 700-800 of the NEC handbook address communications cabling issues.

(g) Building Industry Consulting Service International (BICSI):
(i) Publishes the Telecommunications Distribution Methods Manual (TDM), which is a comprehensive collection of accepted practices in the design and methodology of communications systems. BICSI provides a competency examination for the professional designation as a registered Communications Distribution Designer.
(ii) This manual should be used as a reference only.

(h) Network Equipment Building System (NEBS):
(i) Level 1, Level 2, and Level 3 are applicable to these section.

3 Precautions:
(i) The above list is a partial list issued from standard organization. Additional consideration may be required to provide protection of communications equipments, data processing equipment and
telematics. This protection is essential to maintain the confidentiality of data transmitted across to the network infrastructure, ensuring that data is not intercepted, modified, or destroyed by unauthorized users. It provides a secure network environment to prevent unauthorized access, which is critical for maintaining the integrity and availability of the system.

53.1.6 Quality Assurance

1. The Contractor shall implement the ISO 9001 quality assurance system.

2. This system shall comprise all the participants to the Contract within the Contractor’s teams and its sub-contractors.

3. The Quality Assurance Plan shall be based on quality manuals of the Contractor and sub-contractors.

4. The Contractor shall nominate from the beginning of the Project, the person in charge of quality assurance of the whole project, who is directly linked to the Project Director.

5. The Contractor shall establish from the beginning of the project, the Quality Assurance Plan based on Contractor’s quality system that should define:
   (a) Scope of Quality Assurance Plan, with conditions of validity and revision,
   (b) Organization retained for the Project with sub-contractors list,
   (c) The quality plans of the Contractor.

6. Manufacturer Qualifications
   (a) A firm specialized in providing queue management system materials, integrated supervision interfaced with, but not limited to, the following systems: Structured Cabling Network, Public Address, etc. to that indicated for this Project and with a record of successful in-service performance.

7. Manufacturer’s system shall be a standard "off-the-shelf" package utilizing the latest hardware and software technology.
   (a) Any major system development efforts necessary to meet specified requirements are unacceptable.
   (b) Even if this system is a new concept, it shall not require a huge development and shall be based on existing and proven technologies.

8. Maintenance Center
   (a) The Manufacturer or factory-authorized agency shall maintain a service center capable of providing training, spare parts and emergency maintenance and repairs for overall system at Project site with eight hours maximum response time.

9. Installer Qualifications: Engage an experienced installer who is an authorized representative of the queue management system manufacturer for both installation and maintenance of the type of units required for Project, and whose installations have resulted in construction with a record of successful in-service performance.

10. Materials and Workmanship
(a) Materials and workmanship shall comply with the latest issue of all industry standards, publications, or regulations referenced in this Section, including the following as applicable:

(b) Regulations and Standards: System components, parts and installation are to comply with the corresponding recommendations of the Electronic Industries Association (EIA), and the International Electro-technical Commission (IEC).

(c) Compliance with Local Requirements: Comply with applicable local regulations and code requirements of authorities having jurisdiction. These will have precedence over other codes and standards indicated, unless otherwise approved by the Engineer, in writing.

(d) Conform to requirements of referenced industry standards, applicable sections.

11 Source Limitations

(a) Obtain system components from one Manufacturer who shall assume responsibility for system components and for their compatibility.

53.1.7 Coordination

1 Queue management system is to be fully coordinated with the Structured Cabling Network system and with other interfacing systems (including but not limited to public address system) as required by the Employer.

53.1.8 Warranty

1 Manufacturer’s Warranty: Submit a written warranty signed by the manufacturer and Installer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

(a) Warranty Period: Two years from date of substantial completion of the QMS.

(b) During the guarantee period, the Contractor shall provide, at its own cost, all required spare parts needed to replace existing components unless it is proved that the component to be replaced was damaged by abuse.

2 Experimental Period

(a) There shall be an experimental period of 90 days after successful testing and commissioning of the system, but before issuance of substantial completion certificate. During this period, the Contractor shall undertake supervision and responsibility for operation of the system under actual site conditions. If any malfunctioning or anomaly is noted on the system during this period, it shall be attended immediately. The experimental period will restart automatically from the date of clearing such troubles and start normal operation.

(b) During the experimental period, the Contractor shall undertake supervision and responsibility for operating the system.

(c) After the satisfactory completion of this period, the System is to be taken over by the Employer, as per Contract Conditions, whereby the warranty period is to commence.
3 Manufacturer Product Performance

(a) The Contractor shall provide a Manufacturer endorsed and backed extended 10-years product, performance, application, and labor warranty which shall:

(i) Warrant against defects in materials and workmanship (extended product warranty) for a period of ten (10) years.

(ii) Warrant that all cabling components of the installed system will meet or exceed the specifications of TIA/EIA 568B and ISO/IEC IS 11801 (performance warranty) for a period of ten (10) years.

(iii) Warrant that all unshielded/shielded twisted pair cabling links/channels will meet or exceed the attenuation and NEXT requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of ten (10) years.

(iv) Warrant that all fiber links/channels shall meet or exceed the loss and bandwidth requirements of TIA/EIA TSB 67 and ISO/IEC 11801 (performance warranty) for a period of 10 years.

(v) Warrant that the system shall be application independent and shall support both current and future applications that use the TIA/EIA 568B or ISO/IEC 11801 component and link/channel specifications for cabling (application warranty), for a period of 10 years.

(vi) Warrant that all labor attributable to and required by the above shall be supplied at no cost to the Employer for a period of 10 years.

53.1.9 Maintenance

1 Maintenance Service

(a) The Manufacturer or factory-authorized agency shall maintain a service center capable of providing spare parts and emergency maintenance and repairs for overall system at Project site with eight hours maximum response time.

2 Repair Time or MTTR

(a) The Contractor must commit himself to the following performance that will be checked during the warranty period:

(i) Time for putting back into service the QMS after a problem occurs.

(ii) The monthly average of this time shall be lower or equal to 6 minutes for each device.

(iii) Time to put in place technical and human means to overcome a failure.

(iv) When a technical breakdown requires a time of putting back into service superior to 45 minutes, the Contractor shall apply the technical and human means necessary/required to overcome the failing (resumed by the expected service) during the time of the repair.

(b) The MTTR shall not exceed 30 minutes. The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing
time on site, but shall exclude the response time.

(c) The Contractor’s response time shall not exceed 1 hour. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at where the faulty equipment is located.

3 Maintenance Performance Data

(a) The Contractor shall be committed to the three main sizing data of maintenance:

(i) Annual number of hours of preventive maintenance,

(ii) Annual number of hours of corrective maintenance,

(iii) Average annual cost of spare parts (average based on ten years).

53.1.10 Spare Parts and Extra Materials

1 Generalities

(a) The Contractor shall provide the Manufacturer recommended spare parts for all major components in the queue management system for two years fault free operations.

(b) However a minimum of 2% peripherals of each type installed, but not less than one from each type, shall be included in the deliverable irrespective of Manufacturer recommendation.

2 Spare Parts

(a) During the guarantee period, the Contractor shall provide, at his own cost, all required spare parts needed to replace existing faulty components unless it is proved that the component to be replaced was damaged by abuse, the replacements of the faulty components with a new one shall be done within three days maximum from the date of the faults happening.

3 Extra Materials

(a) Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels clearly describing contents.

(b) QMS Devices:

(i) The quantity of extra materials to be supplied by the Contractor will be proposed and quoted by the Contractor at the tender stage.

(c) Test Equipment:

(i) Provide, together with an itemized list, all test equipment and tools required for routine maintenance, safety checks, and equipment repair.

(ii) Deliver test equipment and tools at the same time as the system equipment.
53.2 PRODUCTS

53.2.1 Design and Operation

1 General Requirements:
   (a) The Queue Management System shall enable the clinic employees to automatically and efficiently manage the flow of patients that visit the clinics and thus to improve the wait time and patient's environment for the clinic services. The system shall enable clinic employees to route, track and prioritize patients, and allow managers to monitor and optimize employee workloads to accommodate patients’ needs through collecting wait-time and transaction time data.

2 The system components include the following equipment located at the counters, in various waiting areas or in the main telecom and security rooms:
   (a) A ticket printer/kiosk dispenser at the clinic main reception,
   (b) Display units c/w speakers at counters and in waiting areas,
   (c) Counter terminals at counters,
   (d) Queue server with printer and storage network, with management and reporting capabilities installed in the main IDF room at the ground floor level with remote monitoring terminals at the Security Room and other remote locations.
   (e) Supervisory Web server, with operations and management functionalities for managers remote supervision.
   (f) Wiring, control cabling, conduit, boxes, weather-proof enclosures, contactors and accessories.
   (g) Queue management system to include interface with structured cabling system, public address and others as coordinated and required by the client.

3 The contractor shall provide all hardware, equipment, software and components for a fully functional queue management system in full compliance with the specifications and with the client’s requirements.

4 Software and Network Standards
   (a) The system shall be Open Database Connectivity (ODBC) compliant.
   (b) TCP/IP shall be the primary LAN communications protocol.
   (c) The latest version of Microsoft SQL Server must be used and the system shall be compatible with Windows 2000/XP desktops.

53.2.2 General System Requirements

1 The Queue management system (QMS) shall have a scalable system architecture designed to accommodate the patients’ flow at the 5 clinics.

2 The QMS system shall be web-based and accessible to users 24 hours a day, 7 days a week.
The QMS system shall be capable of retaining at least 5 years worth of system-performance data, and the storage network shall be dimensioned accordingly. The system shall allow real-time querying and shall be capable of producing real-time ad hoc queries and subsequent reports during normal business hours without affecting the system’s performance.

The QMS system shall have the ability to service patients and to provide each patient with an estimate of their expected waiting time.

The QMS system shall provide the wait time of each patient, from the time of arrival at the QMS kiosk and before the patient is served.

The QMS system shall provide the transaction time of each patient, from the time of arrival at the QMS kiosk until the patient is actually served.

The QMS system shall be able to assign different priorities to different medical employees and/or stations.

The QMS system shall have the capability to prioritize, assign, monitor, and balance employee workloads.

The QMS system shall have audible alarms with an ongoing message screen on the master PC, for recording warning notifications, audible alarm situations, employee assistance calls, and other electronic warnings relative to that location, including situations such as: kiosk dispenser malfunction, management need to address/modify wait time/service time goals and/or need to establish or clarify system service priorities.

The QMS system shall be able to display real time data throughout the day per service on but not limited to: number of patients waiting; average wait time; average service time; number of open stations; current patient service time; total patients served; current or last ticket number served and station utilization percentage.

The QMS system shall allow each station to be continually categorized relative to its daily operating status (i.e., busy, waiting for a patient, closed, idle, uninstalled).

The QMS system shall have a quick reference screen to enable clinic management to see information such as but not limited to: overall patient volume per service and for all services; average wait time and service trends per service and for all services; average patient throughput and queue size per service.

The QMS system shall assign a unique patient number to each service transaction and store the transaction history.

53.2.3 Queue Management Requirements

The QMS system shall be able to manage patient queues for multiple services per clinic.

The QMS system shall allow the development of unlimited workflow routines and patient traffic queues.

The QMS system shall maintain a rules-based engine for workflow routing. The system shall allow designated users to create, modify, and remove rules for
existing tasks or queues. The rules-based engine shall support the routing of work based on data that was captured and stored in the system.

4 The QMS system shall provide a queue maintenance utility that allows designated employees the ability to create, modify, and remove queues.

5 The QMS system shall provide authorized users with the ability to add, delete and edit patient assignments to queues or workflows.

6 The QMS system shall provide designated managers or supervisors the ability to prioritize a waiting patient (e.g. make someone next in line) by re-routing them to any position in the waiting line.

7 The QMS system shall contain a calendar module maintained by management to track employee leave times, which shall automatically adjust workstation availability by clinic.

8 The QMS system shall enable each employee (Patient Agent or Manager) to re-route a waiting patient to another service and/or another station.

9 The QMS system shall provide each service employee the ability through their workstation web browser to open and close her or his station within the system; indicate the arrival of each patient; signal the employee as being open and ready to service the next patient and indicate that the employee is on work mode or on break.

10 The QMS system shall allow each employee to be able to reverse or undo any feature that the employee is able to directly activate or establish.

11 The QMS system shall be able to provide overrides to a normal process of serving the next-in-line ticketed patient (e.g., shall be able to override in favor of a patient with excessive wait time).

12 The QMS system shall permit a workstation(s) to operate in a non-system mode such that the workstation can operate independently of the rules governing selection of the next patient for service at that station(s) management stations shall be industry standard PC’s each with a minimum specification or latest version at the time of purchase.

13 The QMS system shall allow each individual employee to call for supervisory help if needed.

53.2.4 Ticket Printing Capabilities

1 The QMS ticket printers shall have:
   
   (a) Multi-line print capability
   (b) A service-specific barcode
   (c) Numbered tickets per arriving patient.
   (d) Capability to print the following kinds of information on each ticket:

   (i) Date and time of patient arrival for service at clinic
   (ii) Clinic-designated text
(iii) Bitmap image of clinic logo
(iv) Expected wait time
(v) Ticket number

2 The QMS system shall be able to accommodate multiple ticket dispensers per office and dispense tickets from:
   (a) Self-service web kiosks with touch screen interface and a connected printer
   (b) Web-connected workstation PCs at the clinic with a connected printer

3 The QMS ticket printers shall be able to issue an unlimited number of tickets for an unlimited number of distinct and different services.

4 The QMS ticket printers shall provide a warning when:
   (a) Print paper or blank ticket capacity is low; and
   (b) Print paper or blank tickets have run out.

5 The QMS ticket printers shall issue patient tickets per type of service in an unbroken sequence of consecutive numbers.

6 The QMS system shall be capable of printing to the existing receipt printers; plain paper laser printers and other printers connected to the web-connected workstation PCs.

7 The QMS ticket printers shall be furnished by the Contractor and shall accommodate industry standard, non-proprietary paper and other required consumables (i.e. ink cartridges, toner, etc.).

8 The QMS ticket printers shall include self-service Kiosk stations with 1D and 2D barcode readers and touch screens.

53.2.5 Requirements for Waiting Areas

1 The QMS system shall be designed to accommodate patients who will be seated as they wait for service or standing in line for service.

2 The QMS system shall have the option of connectivity to or provision of large screens or monitors for television, video, news, etc. feeds for viewing by waiting patients.

3 The QMS system shall provide signage that can be easily and effectively installed, clearly and easily visible throughout the patient waiting area and that shall fully function as intended and as per client’s requirements.

4 The QMS system shall utilize electronic display signage that can direct a patient to the proper waiting area.

5 The QMS system shall call patients using speakers in LCD.

6 The QMS system shall have the capability to call a patient for service by:
   (a) Manual selection/display/voicing of an operator-chosen patient ticket
number;
(b) Automatic selection/display/voicing of a system-chosen ticket number (e.g., next-in-line patient);
(c) Operator-decision selection/display/voicing of a ticket number chosen by either manual or automatic selection.

53.2.6 Reporting Requirements

1 The QMS system shall create customized performance reports available for printing on demand, and shall show (but not limited to): data per request, per daily, weekly, monthly and year-to-date totals.

2 The QMS system shall capture and store necessary information to be used to easily generate per employee, per station, per service, and per office (global) reports (for various frequencies, such as daily, weekly, monthly, yearly) concerning, but not limited to:

(a) Average patient wait time
(b) Maximum wait time
(c) Wait time per hour,
(d) Per service and total traffic volumes per designated time periods
(e) Actual and average transaction time per service per patient
(f) Per patient arrival and departure time
(g) Patients served per station
(h) Employee productivity
(i) Batch reporting (daily, monthly)

3 The QMS system shall easily format and produce post-implementation reports that are supplementary to those identified in this specification.

4 The QMS system shall contain an internet-deployed reporting system to display data collected. Data shall be displayable in report, table and graph formats. The Internet reporting system shall also contain a functionality that enables users to query data files and create ad-hoc reports concerning the clinics performance. Large report queries shall be scheduled to run after business hours.

5 The QMS system shall contain an internet-deployed reporting system available to the general public using a web browser and an easy-to-use interface. Information displayed shall include wait-times and queue lengths by clinic.

53.2.7 Security Requirements

1 The QMS system shall follow the clinics’ security standard that shall also cover all computers, data and voice networks, wireless systems, web systems of the 5 clinics. The security standard of the 5 clinics shall be requested by the Contractor who shall be entirely and solely responsible to adhering to this security standard to in the implementation of the QMS system.

2 The QMS system shall administer user access, including the granting of specified levels of access, to authorized users and/or classes of users.
3 The QMS system shall provide multiple security profiles. These profiles include, but are not limited to:

(a) System administrator – This individual has overall responsibility for the operation and maintenance of the QMS system.

(b) Business administrator – This individual monitors the use of the system by the clinic units and assists authorized users, if needed.

(c) Patient Agent – This individual is responsible for completing the desired patient service transactions and will usually be the patient point-of-contact. Each activity must have only one assigned Patient Agent.

(d) Management – The individual(s) assigned this role are authorized to perform a variety of tasks, including managing the patient traffic queues, re-allocating staff to meet patient needs, running standard reports and querying the system’s database.

(e) Patient – This is a member of the general public who needs to receive medical assistance in the clinic.

(f) Groups – These are related groups of users with the same level and requirements for access.

4 The QMS system shall provide supervisory override capability so that a user’s access can be re-established if he forgets his password, or some other anomaly prevents the user from logging on.

5 The QMS system shall provide field-level and document-level security for all data under its control, such that any data in fields defined as secure, or documents or reports containing such data, will not be released or otherwise made available to unauthorized entities.

6 All QMS servers must be patched with the latest security updates and virus definitions and scanned by the Contractor.

7 The QMS system shall be designed such that all network connections to external systems and clients outside the clinic’s firewall are controlled in accordance with the local security standards.

53.2.8 Cabling

1 Principles

(a) All wiring and cable shall be installed in metal raceways or within equipment.

(b) Conductors within equipment enclosures shall be carefully wired and laced.

(c) Individual conductors shall be tagged with markers indicating the function, source, and destination of all cabling, wiring and terminals.

(d) All cables and wires shall be identified, utilizing heat-shrink, pre-printed, wire markers.

2 Number of Conductors

(a) As recommended by system Manufacturer for functions indicated.
3 Check-in and Tests
   (a) After installation, and before termination, all wiring and cabling shall be 
       checked and tested to ensure there are no grounds, opens, or shorts on 
       any conductors or shields.
   (b) A V.O.M. shall be utilized to accomplish these tests and a reading of 
       greater than 20 Mega ohms shall be required to successfully complete the 
       test.

4 Visual Inspection
   (a) Visually inspect wire and cable for faulty insulation prior to installation.
   (b) Protect cable ends at all times with acceptable end caps except during 
       actual termination.

5 Protection
   (a) Protect wire and cable from kinks.
   (b) Provide grommets and strain relief material where necessary, to avoid 
       abrasion of wire and excess tension on wire and cable.

6 Splices, Taps, and Terminations
   (a) Make connections only on numbered terminal strips in junction, pull, and 
       outlet boxes; terminal cabinets; and equipment enclosures.

7 Raceways
   (a) Use communications cable tray wherever possible for low voltage cabling.
   (b) Exposed raceway below 2.4 meters and in dry locations shall be rigid steel 
       conduit.

8 Cable Trays
   (a) No QMS containment including cable trays, trunking, ducts, etc. shall be 
       loaded more than 60% of the available space. The Contractor is 
       responsible to size the containment appropriately taking into account all 
       systems and the type of cables to be used based on selected Manufacturer 
       for each system.
   (b) In general, QMS containment route shall follow the electrical containment 
       route with sufficient clearance. However, any other routes followed shall be 
       to the approval of the Engineer.

53.3 EXECUTION

53.3.1 Examination

1 Before installation, examine areas to receive queue management system 
   equipment. Verify that critical dimensions are correct and conditions are 
   acceptable.

2 Proceed with installation only after unsatisfactory conditions have been corrected.
53.3.2 Installation

1 General

(a) Installation shall be supervised and tested by a representative of the Manufacturer of the system equipment. The work shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this work.

(b) Builder's Work: Coordinate positions and foundations for kiosks, displays, terminals, voice modules, servers, etc. Prepare detailed drawings, indicating any service lines, cable ducts, handholes/cable boxes, etc., and templates required for construction. Obtain Engineer's approval before executing any work.

(c) Fixings: Supply steel frame bases, holding-down bolts, nuts, washers etc., before construction of foundations and bases.

(d) Before pulling cables or wires, fix all major equipment in final position and complete all raceways, duct-banks, conduits, handholes/cable boxes and covers.

(e) Electrical Work: Coordinate provision of all necessary electrical components provided by others, and to which control and power wiring is to be provided.

(f) Equipment installation on site is to be limited to the layout and fixation, and inter-wiring of various items of the ready-made equipment.

(g) Acceptance of works is to be restricted to the equipment and installations complying with the approved submittal, approved Shop Drawings, and the agreement of the Engineer.

(h) All installation works, carried out by the Contractor, shall be done under the direct supervision of qualified technicians who are trained and have the relevant experience.

2 Equipment Data

(a) Submit complete technical data including Manufacturer's catalogues and specifications, system description including operational aspects, system features, and components.

3 Shop and Construction Drawings

(a) Submit drawings for approval.

(b) Constraints to be studied by the Contractor as part of its necessary Shop Drawing development include:

(i) The classification of QMS at controlled points does not take into account any materials or specific manufacturing. It refers only to functionalities and equipment to be installed on each side.

(ii) When no space is available above false ceiling for the installation of QMS equipment, an appropriated space can be found either integrated into the floor or nearby an available wall.

(iii) The integration of the QMS hardware (equipment, cables and cable routing) shall be studied in such a way to deliver on site a package
ready for installation.

(iv) It is the Contractor’s duty to coordinate with door hardware as to avoid any technical mismatches.

(v) The Contractor shall ensure the full coordination between the QMS constraints and other systems and any other interfaced system.

(vi) All the QMS systems shall be studied, installed and tested in order to offer an easy maintenance and access.

(vii) All coordination, due by the Contractor, covers both hardware and software. It also covers all aspects of Shop Drawing elaboration, manufacturing, construction, testing and commissioning, to achieve comprehensive systems in proper and efficient working order.

(viii) The final coordination on site with civil works, facades, architecture, HVAC, plumbing, electrical and any other construction aspect, remains the duty of the Contractor.

4 Detailed System Schematic Diagram

(a) Exact routing of cables, giving type and size.

(b) Exact location of all QMS equipment as well as technical rooms.

5 Typical Installation Details of the System Components

(a) After installation, the Employer shall be able to perform hardware configuration changes to redefine any new mapping and modifications as desired without the services of the installer or Manufacturer.

(b) Source codes will be supplied by the installer or Manufacturer.

6 Coordination with Other Works

(a) The Contractor is to undertake the proper coordination between the works and installations of QMS and those of all other systems and interfaces that are listed above.

(b) The layout Shop Drawings is to also reveal the measures taken therein, and every fixation principle, and is to be subject to the approval of the Engineer.

7 Layout of Equipment

(a) All equipment is to be laid out as per the approved Shop Drawings.

(b) After the proper layout of all equipment is accomplished, all components are to be labeled, and marked according to an approved labeling designations and materials.

8 Installation Instructions

(a) Install equipment to comply with Manufacturer’s written instructions, placement drawings and to the approval of the Engineer.

9 Wiring Method
(a) Install wiring in raceway except within consoles, desks, and counters.
(b) Conceal cable and raceway except in unfinished spaces.

10 Splices, Taps, and Terminations
(a) Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.

11 Impedance and Signal Levels
(a) Match input and output impedance and signal levels at signal interfaces. Provide matching networks where required.

12 Identification of Conductors and Cables
(a) Color-code conductors and apply wire and cable marking tape to designate wires and cables to identify media in coordination with system wiring diagrams.

53.3.3 Cleaning and Protecting
1 After installing clean-finished surfaces, touch up shop-applied finishes as required to restore damaged areas.
(a) Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, which ensure queue management system equipment is without damage or deterioration at the time of Substantial Completion.

53.3.4 On-Site Tests and Inspection
1 Equipment and Labor:
(a) Provide all testing equipment and specialists for testing system.

2 On-Site Assembly Verification
(a) The purpose of this phase is to check the assembly and the connection of the equipment without any power supply.
(b) Any verification can give raise to a punch list item either because of an anomaly or a none-conformity.
(c) The verifications are made sequentially for geographical area, each area giving raise to its own punch list.
(d) The punch lists are collated for each module and the phase report is only released when all the stipulations on the punch lists are cleared.

3 Test Plans
(a) Tests are to include insulation resistance, continuity, loop characteristics, signal measurements and analysis, logic routines etc. in accordance with manufacturer's test plan, to be submitted two months before testing, and fully cove performance of components.
(b) All tests are to be carried on according to a detailed Acceptance Test Plan which will be performed in a test environment that duplicates the production environment. The Acceptance Test Plan shall be submitted by the Contractor and approved by the Engineer. The plan shall identify each component of the system, intent of test, method or methods of test and expected results. Each component listed in the plan shall include space for test party signatures, brief comments, time of test and pass/fail check boxes. The plan shall be submitted to the Employer for approval or comment. When Employer Test and Acceptance Plan comments are satisfied and the system is operational, the testing may begin. The component tests shall be compared to the transaction log for accuracy, queries shall be made to narrow the test report to the equipment involved in the test. All components must be checked "pass", signed by all parties and agree with the transaction log to be complete.

(c) The tests are to cover every aspect related to the specifications of the material and their operation including, but not limited to, visual inspections, measurements, and operation.

4 On-Site Cable Tests

(a) Cables are to be tested to ensure that no damage have occurred to them during transportation to site and/or during the course of pulling-in and laying.

5 Inspection

(a) Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

6 Pre-Testing

(a) Align and adjust system and perform pre-testing of all components, wiring and functions to verify compliance with specified requirements.

(b) Correct all deficiencies by replacing malfunctioning or damaged items with new items.

7 Manufacturer's Field Services

(a) Engage a factory-authorized service representative to inspect field-assembled components and equipment installations and perform system pre-testing, testing, adjustment and programming.

(b) Report results in writing.

8 Procedure

(a) Notify the Engineer not less than 30 days in advance, of proposed schedule, procedures and tests to be used in operational testing.

(b) Conduct operational tests only with Engineer present.

9 Report

(a) Prepare a written report of observations, inspections, tests and results, including:
(i) A complete listing of every device and circuit.
(ii) Date of each test and re-test, and by whom.
(iii) Results of each test and, if failure occurred, corrective action taken prior to re-test.

10 Certification
(a) The Contractor shall certify that all devices, circuits and total system finally tested successfully.

11 Operational Tests
(a) Operational tests are to be carried out on system for one week, to test performance of system as if fully operational at peak periods, with all normal and abnormal functions checked and analyzed. Trained staff is to be stationed at various positions to carry out operations and report results. Operations are to include, without limitation, all queue management system operations as well as auditing and management functions.
(b) Schedule tests after pre-testing has been successfully completed.
(c) Perform operational system tests to verify compliance with Specifications.
(d) Test all modes of system operation including:
   (i) Functional operation of each field mounted device.
   (ii) Functional operation of each control circuit.
   (iii) Supervision functions of each initiating, indicating, monitoring, and control circuit.
(e) Integrated Tests with Other Contractors: The test procedures shall reflect the sequence of tests to be performed.
(f) Re-testing: Correct deficiencies and re-test until total system meets requirements of the Specifications and complies with applicable standards. Prepare written records of tests.
(g) Schedule testing with at least seven days advance notice.

12 Experimental Period and System Availability Test
(a) After the on-site tests are satisfactorily completed in accordance with the technical specifications and approved procedures and before final acceptance which is leading to Provisional Taking Over; the Contractor is to assume a three month experimental period during which the system performance will be fully demonstrated under actual operation conditions. Final system acceptance of the entire Project shall be withheld until after successful completion and approval of the fourteen (14) day operational demonstration report. This report shall be submitted to the Employer within five (5) days from completion of the conclusion of the operational demonstration period.
(b) This demonstration is to confirm, to the satisfaction of the Engineer, that the system is free of remarks and is ready for provisional taking over.
(c) The purpose of the System Availability Test (SAT) is to demonstrate that the system is capable of maintaining a 90% availability prior to final...
(d) The SAT will be conducted while the system is in full operation and loaded with normal traffic.

(e) The SAT shall utilize the Contractor’s provided complement of spare parts to minimize downtime due to lack of spare parts. The Contractor at his expense shall replace all such spare parts used by the Contractor during the SAT.

(f) Successful completion of the SAT is a prerequisite to final acceptance of the QMS system.

53.3.5 Demonstration

1 Engage a factory-authorized service representative to train Employer’s maintenance personnel to adjust, operate, and maintain queue management system equipment.

2 Train personnel on procedures to follow if operation fails or malfunctions.

53.3.6 Training

1 Trainers

(a) Engage a factory-authorized service representative to explain programming and operation of system and to train the Employer’s maintenance personnel on procedures and schedules for maintaining, programming, operating, and adjusting, troubleshooting, and servicing system.

2 Training Program

(a) Scope: Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and/or maintain the equipment, systems, and facilities furnished and installed under this Contract, and to ensure a smooth transition between construction and operations activities.

(b) Language: Operators training shall be conducted in English and Arabic, however all technical training shall be in English only.

(c) Training Aids:

(i) Training aids shall include approved operational and maintenance (O & M) manual(s) prepared by the Contractor as part of this Contract; training manuals including course outline, basic text of instructions modules, and trainee workbook; films; slides; video tape(s); charts; models; hand-outs; catalogues; samples and other visual and written aids to complement instruction.

(ii) In addition, spare parts and other special hardware shall be provided to support “hand-on” familiarization with the equipment or systems.

(iii) Upon completion of the training program, all training aids, test equipment, and similar items provided by the Contractor for this training program shall become the property of the Employer.

(d) Training Manuals:
(i) Training manuals in English shall be provided for each training course covering both the classroom and on-the-job training phases.

(ii) The organization of the manuals shall follow the same sequence as the course’s scheduled presentation of material, providing such additional background and supplementary information, as a trainee may need to understand the O&M manuals.

(iii) There should be at least the following training manuals:

1) QMS supervisor training.
2) Electronics maintenance training.
3) Kiosk printer/network/server/workstation terminal/counter terminal/ display/voice modules maintenance training.

(e) Training Execution:

(i) Scope: Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training.

(ii) Contents:

1) Training course can be broken down into modules either classroom lecture or "On-the-job" training.
2) In case of lecture it is the Contractor's responsibility to provide the classroom for the duration of the course.
3) No lecture module should exceed 2 hours time.
4) "On-the-job" training can be scheduled for entire 8-hour shift.
5) At least one module for each maintenance staff should cover the QMS system and its interfaces.
6) Handouts must support each module; the collation of the handouts forms the training manual.
7) Laboratory equipment, spare parts and mock-up models may be used for theoretical orientation.
8) However, practical "hands-on" familiarization shall be provided on equipment that is either installed and operable or ready to be installed and capable of being operated. System spares of special hardware items may be used to support "hands-on" familiarization as long as said spares are returned to inventory in satisfactory condition in accordance with approved procedures.

(iii) Proficiency: At designated intervals each trainee’s proficiency level shall be determined by written, oral and practical performance tests.

53.3.7 Guidelines for Documentation Transmittal

1 Content of the Transmittals

(a) The Contractor shall prepare detail drawings, design calculations, technical data sheets and samples and submit the same for review by the Engineer.
The Contractor shall submit the following key elements to the Engineer for review:

(i) Detailed layout showing the marking and/or the detection equipment as required.

(ii) Manufacturers’ catalogue.

(iii) Provide all relevant testing certificates.

(iv) Inventory label for each item supplied under this Contract. Labels shall be submitted for review by the Engineer and shall be attached to each individual item for easy reference.

(b) Following documents are to be submitted to the owner prior to handing over:

(i) As-built drawings for the relevant areas.

(ii) Complete inventory list.

(iii) Three sets of Operation and Maintenance Manuals are to be provided. Such manuals shall include a full technical description with block and schematic diagrams to allow the Employer’s staff to maintain the machines.

2 Drawings

(a) Note that all design development drawings, construction drawings, and As-Built drawings shall be submitted in hard copy format as well as in electronic format in the quantities specified below.

(b) Quantity of Submittals:

(i) Electronic files: 1 set.

(ii) Reproducible hardcopies: 1 set.

Prints: 3 sets.
Add the following completely new Part titled: Part 54 – Audio & Visual Systems:

54. AUDIO & VISUAL SYSTEMS

54.1 GENERAL

54.1.1 Summary

1 Drawings and general provisions of the Contract, including Terms of Reference and all contractual conditions apply to this Part.

2 All Specifications listed in this specification shall be used as functional performance-based specifications. The Contractor shall be responsible for completing and coordinating requirements necessary to design, furnish and install fully engineered and functional systems. These requirements include any site analysis, furthering of design documents, determination of quantities of equipment, verification of existing conditions and external service providers, and the like. It shall be the responsibility of the Contractor to provide any additional equipment, software, arrangements or infrastructure necessary to complete the system commissioning.

3 A turnkey audio/visual (A/V) presentation system shall be provided for the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf The equipment shall include all hardware, software configuration and accessories required to provide fully functioning systems.

54.1.2 References

1 The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

2 Specific reference in Specifications to codes, rules regulations, standards, manufacturer's instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at date of Contract unless the Document is shown dated.

3 Comply with all local codes and requirements of Authorities Having Jurisdiction (AHJ).

4 References:

(a) ASTM: American Society for Testing Materials
(b) ANSI: American National Standards Institute
(c) Institute of Electrical & Electronics Engineers (IEEE).
(d) Building Industry Consulting Service International (BICSI).
(e) Federal Communications Commission (FCC) regulations and standards.
(f) CFR: Code of Federal Regulations; CFR 47 Part 15; Radio Frequency Devices
(g) IEC 603-7
(h) IEC 60754-1 & 2 Test on Gases Evolved During Combustion of Materials
from Cables and Test on Gases Evolved During Combustion of Electric Cables.

(i) IEC 61034-1 & 2 Test and Measurement of Smoke Density of Cables Burning under Defined Conditions.

(j) IEC 60331 Part 11 & 12, Tests for Electric Cables under Fire Conditions.

(k) IEC 60332 Tests on Electric Cables under Fire Conditions.


(m) ICEA: Insulated Cable Engineers AssociationS-84-608-1994 Telecommunications Cable, Filled, Polyolefin Insulated Copper Conductor

(n) IBC: International Building Code 2006

(o) ISO: International Organization for Standardization

(p) NFPA: National Fire Protection Association
   (i) NFPA 70 (2008)
   (ii) NFPA 72 (2010)
   (iii) NFPA 101 (2009 ed.)
   (iv) NFPA 780 (2008)
   (v) NFPA 5000 (2006 ed.)

(q) NEMA: National Electrical Manufacturers Association (NEMA)

(r) NESC: National Electrical Safety Code

(s) UL: Underwriters Laboratories
   (i) UL 83 Thermoplastic Insulated Wire and Cables
   (ii) UL 96 Lightning Protection Components
   (iii) UL96A Installation Requirements for Lightning Protection Systems
   (iv) UL 467 Grounding and Bonding Equipment
   (v) UL 497 Protectors for Paired-Conductor Communication Circuits

(t) OSHA: Occupational Safety and Health Agency

(u) Local/National Electrical codes.

(v) Local/National Health & Safety codes.

(w) Local and national regulations and codes in effect as of date of purchase.

5 All Local Codes shall prevail. Where local Codes are silent, National Codes and Standards shall be applied. Codes, rules, regulations, and ordinances governing the work, are as fully part of the Specifications as if herein repeated or attached. If the Contractor should note items in the drawings or the specifications, construction of which would be code violations, promptly call them to the attention of the Engineer in writing.

6 Design and Install cabling in accordance with the most recent edition of Building Industry Consulting Services International (BICSI®) publications.
7 Conflicts: Where the requirements of the specifications conflict with other documents the following shall apply:

(a) Between Plans and Specifications, between different specifications, or between different plans: Comply with the one establishing the more stringent requirement.
(b) Between referenced requirements or between industry standards: Comply with the one establishing the more stringent requirements.
(c) Between referenced requirements and Contract documents: Comply with the one establishing the more stringent requirements.

54.1.3 Scope of Work

1 The Audio/Visual System includes, but not limited to, the following types of devices:

(a) AV Control Equipment
(b) AV Control Wired and Wireless Touch Screens
(c) AV Multimedia Switcher
(d) Flat Panel Display
(e) Motorized Projection Screen
(f) Motorized Projector Lift
(g) Video Conferencing Equipment and Camera
(h) Media Input Panels and Media Input Plates
(i) Multi Format Disk Players
(j) Digital Document Camera
(k) Multi-outlet power strips
(l) Wire and Cable
(m) Miscellaneous Connectors and Hardware
(n) AV Room Scheduling and Management Software

2 The AV includes software and hardware components including client software, and interfaces to Local Area Network and other electronic systems.

3 The system shall incorporate an interface to the fire alarm system to display life safety evacuation messages in accordance with NFPA 72.

4 All systems shall be installed in accordance with standard industry methods for a/v systems and in conformity with local area building codes and/or International Building Code (IBC), whichever is the most restrictive.

5 The Contractor shall ensure that all system equipment and materials are installed in a structurally sound manner.

6 The Contractor shall not permanently alter the internal workings and functions of system equipment unless expressly stated in these design and performance specifications. Any modification to the internal workings of electronic equipment
during the installation process shall not be initiated without the prior approval of owner.

7 The Contractor shall perform all setup, programming, focusing adjustments, calibrations, and internal set-up procedures as required by the equipment manufacturer, this Part, and typical installation practices of the industry.

8 The Contractor shall not perform any alteration, procedure, or modification to system equipment which may void in whole, or in part, any manufacturer’s warranty on equipment.

9 Any proposed alternative equipment shall not compromise the system flexibility and future expansion capabilities that are inherent in the system as specified. This is particularly pertinent to the unused video/audio inputs and outputs of the audio and video system, components of lesser capacity or quality than that specified shall be deemed unacceptable.

10 All items specified by this design are specified with prominent characteristics listed for each component. This grouping of equipment components is designed and specified to function as fully compatible units. Equipment substitution requests shall reflect the total group, rather than on a component-by-component basis, which could result in unnecessary interface devices, adapters, loss of modular functions, increased need for rack space, and the potential for signal level or impedance incompatibilities.

11 The hardware, materials and associated equipment required for this system shall not be limited to the items expressly listed in the specifications and descriptions; but shall include all hardware, materials and associated equipment required to deliver a complete audio/visual system which meets all the design and performance specifications.

12 The hardware, materials and associated equipment items shall be of a professional quality consistent with that of the major electronic and mechanical components to which they are associated and connected. Provide these items in any and all quantities as required to assure the presentation system is operational per the design and performance specifications.

13 Coordinate all AV system submittals, installation, and testing with other Contractors responsible for Simulation Systemselectrical systems and other trades as required.

54.1.4 Qualifications

1 Project Qualifications

(a) The Contractor must currently be and have been in the business of selling, installing, and maintaining similar systems at large healthcare facilities for a minimum of five (5) years. The Contractor must have been actively engaged in designing, installing, maintaining and operating similar systems and services as outlined in this document.

(b) The Contractor must have a minimum of three (3) sites that are actively using the same or similar solutions, and each of those solutions must be currently in operation, and have been in operation for at least the preceding twelve (12) months.
(c) The Contractor is required to submit information regarding a minimum of three (3) reference sites that are actively using the same or similar systems. The sites should be similar in terms of number of equipment, devices throughput, and network operations. This reference information shall include the contact name, address, telephone number, and date of original installation for each reference site listed. Additionally, for each reference site detail the features that make it a qualified site (e.g., final system acceptance date, number of devices, etc.).

2 Organization Qualifications

(a) The Contractor shall provide a complete description of organizations and/or firms involved including:
   (i) Involvement of subcontractors or product vendors
   (ii) The name of the Team Leader responsible for the project coordination, development and ongoing Implementation
   (iii) Detailed description of the team and organization chart noting its structure
   (iv) Résumés for key personnel
   (v) Specific role definition including provision for leadership, technical control, teamwork, partnering, coordination and communication
   (vi) Percentage of time committed for the project by each key personnel
   (vii) Mobilization plans for the different phases of the project
   (viii) Listing of all current projects where there is an overlap or potential for overlap of manpower resources. For these projects provide a detailed description of the role, committed level of effort, schedule and completion date for each key individual of the proposed team.

(b) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

54.1.5 Submittals

1 Proposal Submittals:

(a) In addition to all required proposal submittals listed in the appropriate Division, the Contractor shall provide the following submittals:
   (i) Design Approach: In designing the systems, it is desired to standardize hardware, operating systems, etc. in order to facilitate long-term maintenance of the systems. However, the Contractor may propose an alternative solution to any of the design requirements. These alternatives shall be clearly delineated and shall be bid as options, in addition to the base design. Preference shall be given to vendor solutions which best integrate into the overall system design.
   (ii) References: The Contractor is required to submit data sheets for same or similar implementations as specified in the “Qualifications” article of this specification.
   (iii) Qualifications: The Contractor shall supply qualification data sheets
for firms and persons as specified in the “Qualifications” article of this specification to demonstrate their capabilities and experience.

2 Contract Submittals:

(a) Work Plan and Schedule: The Contractor shall supply a schedule of proposed installation and implementation, including dates and milestones within 30 days of contract award. Updates shall be submitted monthly.

(b) Proposed product data sheets: The Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification Part reference for each product. Product data sheets shall be bound in a three ring binder and shall include a product index listing the model number and description of product.

(c) Samples: Submit one sample of the product components and if required a complete assembly.

(d) System Block Diagram: The Contractor shall supply a block diagram that depicts the final system design, including riser diagrams, logical flow, single line diagrams, databases, application servers, communication and distribution methods, and external interfaces.

(e) Configuration: Submit complete lists of all proposed configuration setups, business rules, process flows, and processes implemented in the system. Lists must be submitted weekly during the project and thirty (30) days prior to any formal testing.

(f) Parts Lists: The Contractor shall supply complete Systems parts lists and breakdowns that identify each component (to the lowest repairable unit) as well as ordering information for these parts shall be provided. The characteristics of each component shall also be shown, where applicable, to aid in obtaining substitute parts. Schematics and parts layout drawings to the component level are to be provided when available. The Contractor shall supply a complete list and cross-reference of all supplied documents (i.e., name, brief description, and document number).

(g) Test Plans, Test Procedures and Test Reports: Indicate testing methods, devices, and procedures. Progress payments shall depend on the successful completion of testing and documentation. Provide the test plan at least forty five (45) days prior to the scheduled start of the first test. The test plan shall detail the objectives of all tests and samples of all proposed test forms.

(h) Manufacturers’ system manuals for each system/component provided under the referenced specification Part, including:

(i) Design and Installation.
(ii) Operation/System Administration.
(iii) Maintenance and Service.
(iv) End-user.

(i) Training Plan: Indicate proposed training methods as specified in the “Training” Part of this specification.
(j) Progress Schedule – Contractor shall submit to Project Engineer estimated construction progress schedules for the Work.
(k) Compliance Matrix: Contractor shall submit a compliance matrix that summarizes compliance or non-compliance with each specification component.

3 Supply all documents necessary to enable users to operate all systems and to change feature assignments and software parameters without assistance from the Contractor. This includes a complete listing of all software parameters of the system.

4 Record Drawings: Furnish hardcopy and electronic drawings, in AutoCAD latest format, of completed work including labeling, where applicable.

54.1.6 Warranty

1 General:
   (a) The Contractor shall warrant complete installation of the equipment, system, and software to be free from defects in materials and workmanship for a period of no less than twenty-four (24) months, starting with the date of Substantial Completion. As an option, the Contractor shall supply pricing for an extended Warranty of the system. This option shall be renewable on a yearly basis, and pricing shall be supplied for a minimum of five (5) years from the expiration of the initial Warranty.

2 Hardware Warranty:
   (a) The Contractor shall warrant that the proposed hardware equipment will conform to its description and any applicable specifications, and shall be of good quality for the known purpose for which it is intended. This Warranty shall be in addition to any standard Warranty or service guarantee given by the Contractor to the Employer.
   (b) The Warranty shall allow for replacement or repair of failed systems, equipment and components.
   (c) The hardware warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.
   (d) All hardware installed without an on-site spare shall have a twenty-four (24) hour repair/replacement Warranty from the time the Contractor is notified of the hardware failure.

3 Software Warranty:
   (a) The warranty shall allow for replacement or repair of failed components. All software necessary to compile, modify, and maintain software supplied for this specification shall be included in this warranty.
   (b) The software warranty can be supplied by a service contract. If a service contract is used to provide warranty, the price of the contract shall be separately identified, and shall include a per year price for continuing the contract.
(c) The warranties shall include the price of all software upgrades and computer operating system upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

54.1.7 Quality Assurance

1 General: In addition to the general requirements, the Contractor must have been in the business of selling and installing similar systems for a minimum of five (5) years. The Contractor shall have been actively engaged in installing, maintaining and operating similar systems and services as outlined in the Related Parts portion of this document. The Contractor shall include eighty (80) hours of on-site assistance (excluding travel time) to be used after the final acceptance of the system. This assistance time is in addition to Warranty services and shall be performed on an on-call basis at the Employer’s request.

(a) Unless accepted otherwise by the Engineer, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.

(b) The Contractor shall upgrade each software package and firmware (where applicable) used in the system to the latest version by the end of the Warranty period.

(c) The Contractor shall offer an “Optional One (1) Year Extended Warranty” package renewable for up to five (5) years to the Employer. The Employer shall inform the Contractor of the acceptance or rejection of the first year of the package at the time of final acceptance.

(i) Installation personnel shall meet manufacturer’s training and education requirements for implementation of extended warranty program.

2 NEC Compliance: Comply with NEC as applicable to construction and installation of all system components and accessories including fire rating to all cables and enclosures as applicable.

3 UL Compliance and Labeling: Provide system components, which are UL-listed and labeled.

4 Equipment and materials supplied shall be a standard product of manufacturers regularly engaged in the manufacture and installation of that type of equipment and shall be the manufacturer’s latest standard design. Items of the same classification shall be by the same manufacturer and shall be the same series and model. This requirement includes equipment, modules, assemblies, parts, and components. Electrically powered equipment shall be UL approved. Electronic equipment shall meet the requirements of CFR 47 Part 15.

5 All technicians providing final wire terminations, configurations, and programming on major components shall be manufacturer certified and trained on products being installed under this project.

54.1.8 Delivery, Storage and Handling

1 Delivery: Deliver system components properly packaged in factory-fabricated
type containers. Enclose an operating impact sensor in each container that is holding sensitive electronic equipment. The impact sensor shall be capable of recording a 5G rating.

2 Handling: Handle equipment and components carefully to avoid breakage, impact, denting and scoring finishes. Do not install damaged equipment. Replace and return damaged units to equipment manufacturer.

3 Equipment delivered to the job site shall be opened and inspected immediately upon arriving and compared to the approved Shop Drawing submittal and checked for defects. If the equipment is not correct, the equipment shall be returned to the manufacturer immediately and a new order for the approved equipment shall be placed at no cost to the Employer.

4 Equipment and components shall be protected from the prolonged exposure, weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Employer.

54.1.9 Commissioning

1 During this phase the equipment are powered and the automation and networking are gradually integrated layer by layer.

2 The tests shall be performed by the Contractor and witnessed by the Employer’s Representative.

3 Any defects, which may become apparent during the course of these tests, shall be immediately rectified by the Contractor at his expense.

4 The Site Acceptance Test Specifications shall be prepared by the Contractor and submitted for Approval.

5 All Site Acceptance Tests shall be carried out in the presence of the Employer’s representative who shall sign off the testing documentation on satisfactory completion of the tests.

6 The results of the Site Acceptance Tests, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer’s Representative.

54.2 PRODUCTS

54.2.1 Manufacturers

1 Subject to compliance with requirements, manufactures that may be incorporated in the work, include but are not limited to, those identified in the following Section per device.

54.2.2 Audiovisual and Conferencing System Requirements

1 AV Room Control Equipment

   (a) AV room control system processor shall be provided with the required COM ports, IR, serial, relays, inputs and outputs to provide for the control and
interface of the room touch screens, audio controllers, video displays, video projectors, projector lifts, lighting, curtains, keypads, media panels, video conferencing, etc..

(b) Control systems shall be provided to control operations of the Audiovisual and Conferencing system equipment. The units shall provide interface and programming control between the color touch panels with all video, audio, and control equipment per the system design and the drawings. The units shall enable all system components to perform remote control operations, programming functions, and interface functions as detailed throughout this Specification with respect to equipment and operational controls. The units shall be a solid state device which can be installed within a standard EIA electronics rack. The units shall be provided with Ethernet and serial ports with the ability for all ports to operate simultaneously. Infrared receivers shall only be utilized as a last resort when required interface cannot be achieved using a network or RS232 interface. The units shall be provided with all required remote power control modules. The units shall be provided with all required relays and I/O ports. The unit shall be provided with software to provide system configuration during installation and operations by end users.

(c) Control System shall be fully compatible with Room management software and third party applications (i.e. e-Outlook, e-PowerPoint, etc.).

(d) Network Connections:

(i) Control System shall support 10/100 BaseT Ethernet LAN
(ii) Add-on 10/100 BaseT Ethernet Modules
(iii) TCP/IP Communications
(iv) DHCP and DNS Support
(v) 802.11b and Bluetooth Compatibility
(vi) Native Email Client
(vii) Remote Diagnostics
(viii) Remote Program Loading and Administration
(ix) Built-In Web Server

(e) e. The control system shall include the following hardware configuration:

(i) Eight IR/serial/1-way RS-232 ports.
(ii) Eight digital/analog I/O ports – TTL In/Out & analog inputs 0 10V.
(iii) Eight isolated low-voltage relays – 30VDC @1A.
(iv) Six 2-way RS-232/422/485 ports.
(v) Proprietary control port.
(vi) One compact flash memory upgrade slot.
(vii) Front and rear programming ports.
(viii) Control system shall accept industry standard compact flash

(f) Internal power supply.
(g) Front and rear programming ports.

(h) Control system shall support optional add-on of control cards for IR, RS-232/422/485, relay, digital I/O, analog input, volume, MIDI, etc.

(i) 19" rack mount or shelf mounted chassis (removable rack ears).

(j) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

2 AV Conference Room Control Touch Panels

(a) Color touch panels shall be provided at locations shown in the plans. The units shall offer two-way operation to allow for visual control feedback of system status. The units shall be provided with sufficient internal memory and light and motion sensors to sense activity and illuminate buttons/screen. The screen shall upload and download touch panel pages and graphical objects using supplied control system software. The screen shall include all jacks, adapters and panels required to install and mount the unit and its interfaces.

(b) The design of the color touch panel “pages” and menu system shall be coordinated with and approved by the Owner. Control functions shall be programmed and stored for simplified operations including, but not limited to:

   (i) System power on/off.
   (ii) Video, computer and audio source selection and routing.
   (iii) Disk player transport controls (play, stop, ffwd, etc.).
   (iv) Video display controls (on/off, source select, volume control, etc.).
   (v) Video projector controls (on/off, standby, source select, etc.).
   (vi) Audio teleconferencing external RS-232 controller.
   (vii) Lighting control functions. Refer to lighting control specification.
   (viii) Projector screen and lift control functions.
   (ix) More detailed controls including direct and breakaway routing switcher controls shall also be made available for technical personnel at the color touch panel.
   (x) Various Input and Output Sources Volume Control
   (xi) Assembly, installation and setup shall be done according to instructions provided by the manufacturer.

(c) Wired touch panel (Lectern/furniture mount)

   (i) Shall be an integrated unit
   (ii) Minimum resolution of 800x600 pixels minimum
   (iii) 12" minimum active matrix LCD display
   (iv) Support graphic animation on a variety of object styles.
   (v) Stereo audio input
(vi) Built-in microphone with line level balanced audio output.
(vii) Display NTSC signals with full screen or in user defined windows (scaled video).
(viii) Store and play audio WAV files.
(ix) Touch panel shall have RS-232 Port for touch-coordinate transmission in support of external devices.

(d) Wired touch panel – Wall Mount (basic room/volume control)
   (i) Shall be an integrated unit
   (ii) Minimum resolution of 480x320 pixels minimum
   (iii) 4” (305mm) minimum active matrix LCD display
   (iv) Support graphic animation on a variety of object styles.
   (v) Built-in microphone with line level balanced audio output.
   (vi) Display NTSC/PAL/S-VIDEO signals with full screen or in user defined windows (scaled video).
   (vii) Store and play audio WAV files.
   (viii) Touch panel shall have RS-232 Port for touch-coordinate transmission in support of external devices.

(e) Wireless touch panel – Wall Mount
   (i) Shall be an integrated unit
   (ii) 8.4”(213mm) minimum active matrix display
   (iii) 800 x 600 resolution minimum.
   (iv) Embedded operating system
   (v) Programmable soft key buttons
   (vi) Applications for web browsing, streaming media, conferencing, VoiP, and remote computer access.
   (vii) Streaming video from network cameras and servers
   (viii) Built in microphone and stereo speakers
   (ix) Bluetooth technology
   (x) Wired 10/100 ethernet
   (xi) 802.11 a/b/g Wifi communications

(f) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

(g) The Contractor shall develop the final color touch control panel layouts which build upon the design intent. Final control panel layouts submitted by the Contractor shall include additional functions as detailed and as determined necessary during the pre-installation and pre-system programming meetings. Final layout designs shall be adequate to deliver a
fully functional hardwired control system.

3 Multimedia AV Switcher

(a) I/O configuration quantity as necessary to provide connections as needed by all AV components plus 50% spare.
(b) Configurable input card slots. Include inputs for connections as needed by all AV components plus 50% spare.
(c) Configurable output card slots. Include inputs for connections needed by all AV components plus 50% spare.
(d) Resolutions up to 1920x1200, including HDTV 1080p/60
(e) DVI-D/HDMI and stereo audio matrix switching
(f) Shall support EDID channel to all outputs
(g) Shall support HDCP compliance across selected I/O matrix
(h) Shall support HDMI v.1.3b control and audio
(i) Source signal presence indication
(j) RS-232
(k) Software set up tool
(l) Integrated 10/100 managed ethernet switch with gigabit uplink
(m) Rack-mountable metal enclosure
(n) Power supply included
(o) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

4 Media Transmitters

(a) Formats: HDMI, DVI, HDCP content protection support, HDTV up to 1080p60 NTSC, EDID format management, CEC
(b) (1) DVI-I input
(c) (1) HDMI input
(d) (1) Balanced audio in: 3.5 mm 5 pin
(e) (1) Audio input SPDIF(1) RCA female
(f) (1) Audio in unbalanced (2) RCA female
(g) Video in (3) RCA female, Component, S Video or composite input
(h) (1) HDMI out
(i) (2) SC female optical fiber HDMI extended signal outputs for signal transmission up to 1000 ft.
(j) Power: 24 VDC with power supply
(k) IR: (1) 2 pin 3.5mm terminal IR serial port
(l) COM: RS-232
(m) LAN: 10 baseT/100 Base TX Ethernet RJ-45

(n) Basis of Design: Crestron DM-TX-300N-F or approved other approved equivalent.

(o) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

5 Media Receivers

(a) Receiver shall accept HD signal via STP cable and convert it to HDMI.

(b) Formats: HDMI, HDCP content protection support, HDTV up to 1080p60 NTSC, EDID format management, CEC

(c) (1) HDMI input

(d) (1) USB

(e) (2) relays, normally open

(f) (1) contact closure sensing input

(g) RS-232

(h) (2) IR serial ports

(i) LAN: 10 baseT/100 Base TX Ethernet RJ-45

(j) Basis of Design: Crestron DM-RMC-100

(k) Manufactures:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

6 Flat Panel displays

(a) Display Diagonal Sizes: 63-65" shall be coordinated with and confirmed by the Employer; refer to drawings for locations.

(b) LED or LED/LCD Technology

(c) Colors --- 16.7 million

(d) 1920 x 1080p @ 60Hz (Analog / Digital) Minimum native resolution
   (i) Maximum 2560 x 1600 @ 75Hz (Analog)
   (ii) Maximum 2560 x 1600 @ 60Hz (Digital)

(e) 5 ms Display Response Time

(f) ATSC HDTV tuner

(g) Closed Caption Decoder


(i) Anti-Glare, Anti-Reflective screen treatment

(j) Operating Temperature --- 0° to 35°C (32° to 95°F)

(k) Operating Humidity --- 20% to 90%, non condensing
(l) Power Save mode
(m) Power Timer
(n) Internal Power Supply
(o) 120V, 60Hz Power Requirements
(p) System management and control via Ethernet LAN
(q) Audio Power 20W (10W x 2) minimum
(r) Formats Supported
   (i) HDTV Formats 720p / 1080p Minimum
   (ii) NTSC
   (iii) ATSC
   (iv) VESA type graphics, up to 1920x1200 (WUXGA) minimum
(s) Analog Video inputs
   (i) RGBHV on 75-Ohm BHC (and/or) PC Video Input Analog HD15
   (ii) Component Video (Y/Pb/Pr ) Input
   (iii) S-Video Input
   (iv) Composite Video Input
(t) Digital Video inputs: (2)HDMI HDCP Compliant, (v) 1.3b compliant or later, DVI
(u) Control inputs
   (i) Ethernet/TCP-IP (RJ-45)
   (ii) RS232 Control
   (iii) Infrared
(v) Accessories: User’s Manual, power cord, wireless remote control and remote mouse receiver with batteries.
(w) Provide VESA wall mounted bracket unless otherwise noted with tilt adjustment: +5 ° -15 °. Weight Capacity shall be rated twice complete display (including speakers) weight. When ceiling pipe mounted, provide 25 ° tilt adjustment.
(x) Program Speaker Mounted on Flat Panel Display
   (i) 20 Watt minimum power handling at 8 Ohm
   (ii) 90° x 90° deg minimum coverage,
   (iii) 86 dB minimum sensitivity,
   (iv) 80-16K Hz frequency response, ±3 dB.
   (v) Accessories: Mounting bracket
(y) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

7 Projector Ceiling Mount:
(a) The Projector Ceiling Mount shall be mounted where indicated on the plans and shall provide a multidirectional positioning (roll, pitch, and yaw) for proper image alignment. The multidirectional positioning mechanism shall provide 30° Roll (+/- 15°); 30° Pitch (+/- 15°) and 360° Yaw all with positive lock at any degree.

(b) The Projector Ceiling Mount shall include a structural ceiling plate and an extension column connector using a 38mm diameter extension column compatible with the supplied Projector Mount. The Projector Mount shall be provided with all screws, applicable Joist/I-Beam/Truss/Suspended Ceiling/Anchor adapter, stabilizer kit, cord management, sleeves and hardware required to lock the extension column and feed cables to the projector. The Projector Mount, ceiling plate and extension column shall be finished in black fused epoxy. The Projector Mount shall offer quick and easy access to replace the projector lamp and/or filter and shall be UL listed.

(c) Assembly and installation shall be done according to instructions provided by the manufacturer.

(d) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

8 Motorized Projection Screen

(a) Configuration: As detailed on plans and plan schedules and to be coordinated with the Client.

(b) Product: Motorized projections screens shall be complete, and include case, roller/motor assembly, screen material, low-voltage controller and switch

(c) Materials: Matte White: Screen material shall be a flame retardant, mildew resistant, vinyl screen that can be rolled and cleaned with mild soap and water solution. Screen material shall be provided with an opaque black backing. Screen surface shall be tensioned, unity-gain matte white and have a black masking border. Screen shall conform to a 16:9 (1.778:1) aspect ratio.

(d) Gain: 1.0.

(e) Viewing angle: 50 degrees.

(f) Housing and Finish: Screen shall be housed in a ceiling recessed, extruded aluminum or formed sheet-steel case with end-bracket flanges for mounting on threaded rods. Case shall be plenum rated. Screen roller shall be electrically operated, permanently mount screen material, and include screen tensioning system. Screen shall be finished in white or matte-black power coat, as per approval of the Architect and Consultant.

(g) Tensioning system: Shall be adjustable tab guide cable system to maintain even lateral tension and to hold viewing surface flat.

(h) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer
9 Motorized Projector Lifts

(a) Configuration: As detailed on plans and plan schedules.

(b) Product: Motorized projector lifts shall be complete, and include frame, enclosure, closure, roller/motor/scissors assembly, mount, low-voltage controller and switch. Lift lowering mechanism shall include wireway for management and protection of cables feeding down to projector. Lift shall be provided with mounting brackets and hardware to allow mounting to deck above and trim and closure materials to match and allow flush mounting in rigid and suspended ceiling types.

(c) Materials: Lifts for Large Projectors (greater than 12,000 lumen)

(d) Maximum weight capacity of up to 300 kg.

(e) Maximum lowering distance of 6850 mm.

(f) Lifts for Small and Mid-sized Projectors (less than 12,000 lumen)

(g) Maximum weight capacity of up to 180 kg.

(h) Maximum lowering distance of 3000 mm.

(i) Housing and Finish: Lift shall be housed in an approved sheet metal enclosure, to match lift size and model by manufacturer. Enclosure shall be finished in matte black to obscure view of interior. Ceiling closure shall include outside and inside trim, closure panel. Closure trim and support shall include fine adjustment to ensure flush appearance with surrounding trim and ceiling. Closure panel and trim shall be of type and finish as approved by Architect and Consultant.

(j) Lift shall have mechanism which locks lowering drum in position when lift is in position.

(k) Lift shall maintain projector in stable, fixed position when in use, with negligible lateral movement or “sway”. Lift shall be rated for installation in seismic environments.

(l) Provide three positions, with adjustable field programmable limits for the following positions:
   (i) Storage (flush in ceiling)
   (ii) Show (projector in use)
   (iii) Service (lowered to allow maintenance at maximum of 1200mm AFF)

(m) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

10 Distance Learning/Video Conference Codec and Capture

(a) Video resolution 1080i/p & 720p (1920x1080 & 1280 x 720 pixels)

(b) IP Based: ITU-T, H.323 IETF-SIP (RFC3261)


(d) Video Inputs: (2) HDMI, (2) DVI-I, (1) Composite
(e) Video Outputs: (1) HDMI, (1) DVI-I, (1) Composite
(f) Audio Inputs: (4) Mic XLR, (2) RCA, (1) HDMI
(g) Audio Outputs: (2) RCA, (1) HDMI
(h) LAN Network Interface: 10/100/1000 Mbps RJ-45
(i) H.323/SIP up to 6Mbps point to point, 10 Mbps multi site bandwidth
(j) Multi-point conference unit shall support conferences over IP/Ethernet. For total of 4 sites over Ethernet HD collaboration up to 4 HD sources (3 simultaneous) 1080p30/UXGA res.
(k) 2/2+ or 4 HD Video Outputs depending on the room size and functionality.
(l) Supported Video Monitor
   (i) Format PAL, NTSC, HighDef
   (ii) Single, Dual monitor mode, HighDef
   (iii) Picture in picture PAP function
   (iv) 16:9
   (v) Dual Monitor Emulation
(m) Video Capture
   (i) DVI-I, Analog RGB, S-Video, Composite Video Inputs
   (ii) 1920 X 1080 maximum resolution
   (iii) Digital and Analog Audio Inputs - IEEE 1394, XLR Balanced Stereo, RCA Unbalanced Stereo
   (iv) Webcast Live/Record On Demand
   (v) Simultaneous Video, Graphics, and Audio Capture
   (vi) 56Kbps to 2 Mbps encoding
(n) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

11 Camera

(a) Resolution: HD 1080p, 1080i, 720p
(b) Formats: SDI/HDSDI, High-Definition (RGB, YPbPr), NTSC, PAL
(c) Pan Tilt Zoom: PAN ± 100°, TILT ± 25°, Zoom 10x (optical)
(d) Horizontal resolution: 460 TV Lines, minimum
(e) Total Horizontal field of view: 267 degrees.
(f) Horizontal field of view: 77 degrees.
(g) Total Vertical field of view: 96 degrees.
(h) Vertical field of view: 61 degrees.
(i) Min. illumination 50 Lux (F1.8)
(j) 16:9 Aspect ratio
(k) Auto or manual focus / brightness / white balance
(l) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

12 Media Input Panels(MP)

(a) Flush mount, flip top unit in tabletop, AV inputs Analog D-Sub, 3.5mm Audio, S - Video with Audio.
(b) Flush mount in tabletop.
(c) Finish selected by architect.
(d) All cables and connectors to connect the MP to source equipment, rack shelf mounting kits and transmission devices shall be provided as part of this project.
(e) The MPs shall be UL listed. Assembly, installation and setup shall be done according to instructions provided by the manufacturer.
(f) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

13 Input plates(IP)

(a) Wall or lectern mounted
(b) Include connectors, adapters, pass throughs to provide connections as noted on block diagrams.
(c) All cables and connectors to connect the IP to source equipment, rack shelf mounting kits and transmission devices shall be provided as part of this project.
(d) The IPs shall be UL listed. Assembly, installation and setup shall be done according to instructions provided by the manufacturer.
(e) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer

14 Multi-Format DVD player

(a) DVI/HDMI v.1.3b video output with multichannel audio stream (HDMI or SPDIF)
(b) 1080p output resolution
(c) Play video and images (jpg, jpeg, gif, png, and other common formats)
(d) Memory card slot for standard SD memory card, compact flash, memory stick, multimedia card and smart media.
(f) Built in 802.11b/g
(g) Power Source: 220V, 60 Hz

(h) Audio: 192 Khz/24 bit, Dolby digital

(i) Manufacturers:

(i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

15 Miscellaneous Hardware, Materials, and Associated Equipment:

(a) Provide and install all hardware, materials, custom panels, wall boxes, floor boxes, rack panels and associated equipment for the complete installation of this system as designed.

(b) Rack Accessories: Provide all rack/cabinet mounting kits and accessories including, but not limited to, fixed shelves, locking slide shelves, horizontal tray, vertical cabling ring section, vertical mounting rail and bracing kits.

(c) Supply and install all wire and cable as required to complete the installation of all systems as designed and specified.

(d) Include required connectors, couplers, adapters, gender switcher, cable extenders, patch panels and jumper cables: HDMI, DVI-I, DVI-D, TIA/EIA Category 6A patch cords, BNC, HD-15, RCA, S-video, F, XLR Balanced, RCA unbalanced, 3.5mm mini types. Passive USB Cables less than 15 ft or Active USB cable. RS232/422/485 to Ethernet Converter: Low profile single port converter for field devices, and 19" rack mounted devices for equipment room installations.

(e) Connection Plate Receptacles

(i) Audio (microphone) – XLR type.

(ii) Audio (line level) – ¼ inch diameter tip/ring/sleeve type, or as required by the intercom system. Jack shall be insulated from panel type.

(iii) Audio (loudspeaker level) – Neutrik “Speak-On” Type.

(iv) Intercom – ¼ inch diameter tip/ring/sleeve type, or as required by the intercom system. Jack shall be insulated from panel type.

(v) Video – BNC type.

(vi) DVI – DVI-I jack, isolated from panel type, with hex nuts.

(vii) RF – “F” type. Receptacles shall be insulated from panel type.

(viii) Note: All connectors on wall plates, or in other exposed locations, are to be recessed.

(f) Manufacturers:

(i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

16 Power Conditioner

(a) Basis of Design: Furman PL- 8C or other approved equivalent rack mounted in IT or AV room where noted on rack elevations.

(b) Manufacturers:
Wire and Cable

(a) Cable Selection: Signal type shall be typically indicated on block diagram at equipment input or output.

(b) Plenum Rated / Non-Plenum Ratings: Cable routed in conduits or equipment racks to have non-plenum rated (PVC) jacket. All other cables to have plenum rated jacket. Cable to be run continuous without splices.

(c) Microphone and Line Cable:
   (i) Configuration: Type CMR – 22 AWG (7x30) stranded twisted shielded pair with overall shield.
   (ii) Plenum Configuration: Type CMP – 22/2 AWG (7x30) stranded twisted shielded pair with overall shield.

(d) Low Impedance Loudspeaker Cable:
   (i) Configuration: Type CL3 – 12 AWG (19x25) stranded twisted pair.

(e) High Impedance Loudspeaker Cable (25V / 100V)
   (i) Configuration: Type CMR – 18 AWG, (7x26) stranded pair.

(f) Wireless Microphone Antenna Cables with-in equipment racks
   (i) Configuration: Type CM 50 ohm RG-58/U 22 AWG solid center conductor.

(g) Wireless Microphone Antenna Cables outside of equipment racks.
   (i) Configuration: Type CM 50 ohm RG-8/U 11 AWG, (7x19) center conductor.

(h) Video Tie Line Cable:
   (i) Configuration: Type CM RG6/U coaxial cable 18 AWG solid bare copper.

(i) HD Video Cable:
   (i) Configuration: Type HDMI 1.3b, full 1080p resolution up to 120 Hz refresh rate, CL3 rated, HDMI-CEC system control compatibility, lossless multi channel digital audio.

(j) RS-232 Control Cable
   (i) Configuration: Type CL3R, Two Pair twisted shielded with overall shield, 22 AWG, (7x30)

(k) Specialty Control Cable:
   (i) Control and communication cable as required for DSP configuration to be verified and included.

(l) Manufacturers:
   (i) Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer
54.3 EXECUTION

54.3.1 Examination

1 The Employer assumes no responsibility or liability for transportation from country of origin, storage fees, drayage, import taxes, duty taxes, or other costs associated with the delivery and storage of system components.

2 Contractor shall be responsible for any and all loss or damage in the shipment and delivery of all material until transfer of title to the Employer.

3 Contractor shall store products in accordance with manufacturer's instructions, within Contractor's staging area and with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

4 Contractor shall provide coverings to protect products from damage from traffic and construction operations, remove when no longer needed.

5 Contractor shall ensure that all work performed under these Specifications is in accordance with the requirements and standards defined and referenced in these Specifications. Any work performed in deviation of these Specifications, any of the referenced material, or any applicable standards or requirements, shall immediately be corrected by the Contractor without additional charges, regardless of the stage of completion. The Contractor shall record all inspection observations. As a minimum, the record shall include the name(s) of personnel conducting the inspection, a brief description of the inspection and the observations. These records shall be available for the Engineer to review at any time. Also, these records shall be delivered to the Engineer before final acceptance.

6 Installation Inspections: Installation inspections shall be undertaken through the performance of pre-installation, in-progress, and final inspections as follows:

(a) Pre-Installation Inspection: The Contractor shall make an inspection of all equipment and material to be used prior to installation. All items shall be verified for compliance with the requirements of these Specifications and all other applicable standards. All equipment, cable, and associated hardware identified for installation shall be inspected for damage and completeness utilizing standard practices to determine integrity and acceptability.

(b) In-Progress Inspection: At the Engineer's discretion, the Contractor shall perform in-progress inspections that shall include visual inspections of equipment, wiring practices, cabling, placement of equipment, marking of cables and adherence to safety procedures. In addition, the Employer, or his representative, may conduct additional inspections any time.

(c) Final Inspection: The Contractor shall conduct a final inspection that encompasses all portions of the installation. This inspection shall be performed to ensure that all aspects of the installation have been performed in accordance with these Specifications, standard industry practices and the publications referenced herein. All non-compliance items shall be noted by the Contractor during this inspection. The Engineer shall witness this inspection.

(d) Corrective Action and Verification Inspection: The Contractor shall perform
54.3.2 Installation

1 Standards: All installation activities shall be performed in a neat and professional manner in accordance with all applicable local and national codes. Additionally, the Contractor and all subsequent Sub-Contractors employed to satisfy the requirements of these specifications shall obtain, or satisfy, the following prior to installation:
   
   (a) All licenses and permits
   (b) All insurance and bonding as required
   (c) All other standards or requirements specified in this document

2 Contractor shall install and inspect all hardware required in this specification in accordance with the manufacturer's installation instructions.

3 Contractor shall adhere to the following during installation of the system:

   (a) Underwriter’s Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electric Code for customer premise installations.

   (b) Fire resistance requirements specified by Underwriter’s Laboratories in UL 1459, 2nd edition.

4 Where undefined by codes and standards, Contractor shall apply a safety factor of at least two (2) times the rated load to all fastenings and supports of system components.

5 Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

6 Rack Mounted Equipment:

   (a) As a general practice, Contractor shall run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the rear.

   (b) The Contractor shall run other cables on the right side of an equipment rack, as viewed from the rear.

   (c) For equipment mounted in drawers or on slides, provide the rack accessories as well as interconnecting cables with a service loop of not less than three feet and ensure that the cable is long enough to allow full extension of drawer or slide.

7 Contractor shall install all custom and packaged software in the development and production environments.

8 Contractor shall provide a migration plan for all new and updated software to be migrated from within the development environment to the production
environment.

9 Final hardware selected and installation of hardware shall be submitted for review by the Engineer. Additionally, the Contractor shall review the cabinets and equipment room to ensure ventilation requirements are met or recommend modifications.

10 Contractor shall install and configure all software required in this Specification in accordance with the software manufacturer’s installation instructions. Apply the latest patches and security updates. Register the application with the manufacturer under the Employer’s name.

11 The contractor shall facilitate, configure, document and test all network connections required by other systems or other facilities not in contract that require access to the network specified herein.

12 Contractor shall place materials only in those locations that have been previously authorized. Any other locations shall be authorized, in writing, by the Engineer.

13 Contractor shall provide all tools, applications and test equipment required to install, verify, and test the installation and to determine that it meets the specifications. The Contractor shall furnish all necessary materials required to implement and to achieve the required work performance.

14 Installation of audio/visual systems:

(a) Install and test the audio/visual presentation system per the design requirements. Supply all cable, wire, connectors, hardware, materials, parts, and labor necessary for the complete installation of the system, in accordance with the recommendations of the specific equipment manufacturers, in accordance with the requirements of the specifications and standard industry methods, such as the International Communications Industries Association.

(b) Include the necessary test equipment, supplies, materials, tools, expendables, caulking, acoustic batting, seals, wire ties, safety equipment, ladders, scaffolding, and support materials required for completion of the installation work per the contract. Provide these and all other related materials and support services such as photocopying documents, computer disks, blueprint work, and CAD services as needed to produce completed systems. In addition, the Contractor shall be responsible for all warranties and service contracts throughout the term of the contract.

(c) Include equipment delivery, unloading, uncrating, setting in place, fastenings to walls, floors, ceilings, podiums or other structures, where required for installation. Include interconnection of wiring of the system components; equipment alignment and adjustment; and all other Work, whether or not expressly stated herein, which is necessary to result in complete, tested, and fully operational systems.

(d) Installation practices shall be in accordance with the contract documents. The applicable standards, requirements, and recommendations of the Owner Building Codes, the National Electrical Code, and all local authorities having jurisdiction will apply to this installation. All installation work must follow “Standard Broadcast Wiring” and installation practices as excerpted from “Recommended Wiring Practices,” Sound System...
Engineering, (2nd Edition) D. Davis, and performed to the highest standards of acknowledged industry practices.

(e) If, in the opinion of the Contractor, an installation practice is desired, or required, which is contrary to the specifications or drawings, such installation shall not commence until a written request for modification has been made to the Owner and approved by the Owner.

(f) Protect the finished and unfinished Work against damage, and/or repair such Work, as required, at no cost to the Owner, during the installation and up to the date of Final Acceptance.

(g) Ensure that all installation personnel on the job site are in compliance with all OSHA personal safety requirements for a construction site of this scope and for the Work required. Include the wearing of hard hats, eye protection, particle masks, gloves, and any other job site safety standards or security requirements as set forth by the Owner, dictated by location codes, and/or recommended by the manufacturer of a product being installed or used.

(h) Ensure no signal cables are placed on top of any lighting fixtures, ceiling speakers, video projector lifts, projection screens, HVAC controls or sensing devices, fire safety and sprinkler system detection electronics, or any other electronic or mechanical equipment in plenum areas. Adhere to the new electrical codes for low voltage wiring.

(i) No cables shall be laid directly on top of T-bar grid ceiling tiles. All wiring and cables shall be installed in conduit, cable tray or J hooks.

(j) Do not install system cables in a manner that will block access to other equipment or services, which will cross removable service panels and/or in any other manner prohibit routine maintenance of HVAC systems, fire safety equipment, and building mechanical control systems.

(k) Prior to installation, notify and resolve with the Owner any wire path routing conflicts.

15 Physical Installation of Equipment:

(a) Firmly secure non-portable equipment in place. Use fastenings and supports adequate to support their loads with a safety factor of at least five (5) times the weight of the equipment. Structural mounting that is not able to meet this requirement due to the specific nature of the equipment, manufacturer’s requirements, or limitations of the facility, shall not be installed without the Owner’s approval.

(b) Install boxes, equipment, hardware, and other materials plumb, level, and square.

(c) Install system equipment within the electronic equipment rack as detailed on the rack layouts. Any design changes or reconfiguration of equipment elevation placements within electronic racks shall require approval by the Owner.

(d) Install electronic equipment and support equipment in desks, tables, conference tables, and the other millwork in a neat and cosmetically dressed-out manner. Saw-cuts, holes and recesses into laminates and woodwork shall be straight, radius and circular cuts shall be consistent, and uneven surfaces shall be corrected. Include the use of moldings,
grommets, bushings, laminates, and wood products as required to dress out the installation of equipment.

(e) Use matching screws, hardware and grommets on the front of racks.

(f) All rack-mounted devices shall be secured to the rack or supporting shelf using appropriate fasteners to ensure proper mounting and continuous grounding.

(g) All non rack-mounted devices shall be grounded using an approved grounding technique or as recommended by the manufacturer.

16 Installation of Audio and Visual Systems:

(a) Install and adjust the specified system components to achieve conformance with the individual component manufacturer’s specifications as well as the overall system performance requirements.

(b) Provide and install all necessary low voltage wiring, portable power cords, connectors, and labor associated with the control and signal requirements for projection equipment.

17 Cable and Connector Installation:

(a) Provide (except as noted on the drawings) necessary wire and cable and pull wire and cable to all locations defined within the parameters of this specification for the inter-connection of equipment.

(b) Dress exposed cable with helical nylon wrap.

(c) Neatly lace, dress, strain relieves and adequately supports internal rack cabling.

(d) All cable installation shall conform to industry standards. Coordinate installation with the Owner. This coordination shall include the placement of cables within cable trays to ensure proper separation of this system’s cables from the telecommunication and video wiring.

(e) Do not place any wires and cables for this system in any conduit, raceway, wire-way or cable tray that is used for the mechanical, fire alarm, security or high voltage systems of the building.

(f) Group all internal rack cables according to the signals being carried to reduce signal contamination.

(g) Form separate groups for the following:
   (i) Power.
   (ii) Control cables.
   (iii) Video cables.
   (iv) Audio cables carrying signals less than -20 dBm.
   (v) Audio cables carrying signals between -20 dBm and +20 dBm.
   (vi) Audio cables carrying signals above +20 dBm.

(h) Route all cable and wiring within equipment racks, cabinets and millwork according to function, separating wires of different signal levels (microphone, line level, amplifier output, AC, control, etc.) by as much distance as possible. Neatly arrange, harness and bundle all cable with
nylon ties.

(i) As a general practice, run power cables, control cables, and high level cables on the left side of equipment racks as viewed from the rear. Run all other cables on the right side of all equipment racks as viewed from the rear.

(j) Cut all cables, except video cables (which must be cut to an electrical length), to the length dictated by the cable run.

(k) Supply and install required terminal blocks, boards, strips, connectors or patch panels for all cables which interface with racks, cabinets, consoles, or equipment modules.

(l) Observe proper circuit polarity and loudspeaker wiring polarity. Clearly label connections and wires as to function and polarity. Wires patch panels and connectors as follows:

<table>
<thead>
<tr>
<th>WIRE</th>
<th>CONNECTOR</th>
<th>SIGNAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red or White</td>
<td>Pin #2</td>
<td>Hi or POS</td>
</tr>
<tr>
<td>Black</td>
<td>Pin #3</td>
<td>Lo or Neg</td>
</tr>
<tr>
<td>Shield</td>
<td>Pin #1</td>
<td>Ground or Common</td>
</tr>
</tbody>
</table>

(m) Cables shall not be wired with a polarity reversal between connectors at either end. Take special care when wiring microphone cables to ensure that constant polarity is maintained.

(n) Provide all circuits, balanced and floating, except as noted in these specifications or directed by the Owner at the time of final equalization and testing.

(o) All system wire, except spare wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means. No bare wire ends will be accepted.

(p) Use heat-shrink type tubing to insulate and dress the ends of wire and cables, including a separate tube for the ground or drain wire.

(q) Make all solder connections with rosin-core solder. Use temperature-controlled soldering irons rated at least 60 watts for all soldering work. No soldering guns, gas or butane, or temperature-unregulated irons will be allowed on the job site. (The presence of such soldering tools on the job site will constitute evidence of solder connections made with unauthorized tools and will be grounds for rejection of all solder connections in the system and the subsequent re-work of same.)

(r) Mechanical connections shall be made with approved crimp lugs of the correct size and type for the connection. Wire nuts will not be permitted. Attach each connector with the proper size controlled-duty-cycle ratcheting crimp tool approved by the manufacturer of the connectors.

(s) Conventional non-ratcheting type crimping tools are unacceptable, and shall not be used on the job site. (The presence of such tools on the job site will constitute evidence of mechanical connections made with unauthorized tools and will be grounds for rejection of all mechanical connections in the system and the subsequent re-work of same.)

(t) Equipment shall be held firmly in place with proper types of mounting
hardware as recommended and/or supplied by the manufacturer. Mounting hardware provided with equipment shall be used when practical. This includes front and rear rack rails, angle brackets, and rack slide kits. The equipment shall be installed so that it ensures reasonable safety for the operator. Supply adequate ventilation for enclosed equipment items which produce heat.

(u) Ground all shields for audio cables only at the input end of the various equipment items on the system to limit potential for ground loops.

54.3.3 Documentation

1 This Part requires complete documentation of all systems for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts. All documentation, as described herein shall be submitted to the Engineer for approval sixty (60) days prior to final submission.

2 Scope: The Contractor shall provide the Employer with Operation and Maintenance Manuals and other documentation on all installed systems. These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.

3 The maintenance manual requirement of this Part is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing, and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.

4 Maintenance Manuals, Manufacturer's Literature: Provide manufacturer’s standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.

5 Drawing Books: All Drawings developed specifically for this Project shall be reduced to half-size, folded and bound with hard plastic covers. The half-size Drawings provided shall be easily readable after printing, even if this requires breaking large Drawings into several parts. Text shall be no smaller than 2 mm. The drawing book documents shall be produced with current version of AutoCAD and the electronic files shall be provided to the Employer at the completion of the Project on DVD/CD-ROM. Provide component identification and cross reference on the Drawings to allow the maintenance department to understand the function of each item (the block diagram), find the room where the device is mounted (Contract Document plans), find its location in a rack (Arrangement Drawings), find how it is wired (wiring diagrams), and its detailed Specifications (vendor data sheets), and how to repair it (spare part lists). Include the following drawings as a minimum:
(a) System Block Diagram: This drawings shall depict the final LAN overview, including equipment types, location, IP addresses and any special information

(b) System Riser Diagram(s): These drawings shall show all LAN components, wire numbers, color codes, pin numbers, component locations and connections, depicting the “as-built”, final configuration

(c) Rack Elevation and Wiring Diagram(s): The elevation diagrams shall depict the front views of the equipment racks identifying all equipment installed within. Complete wiring diagrams of the racks shall also be included

(d) Floor plans of the communications rooms showing the location of all equipment effected as a part of this contract within the communications rooms

(e) Elevation drawings of all wall mounted equipment showing the location of each component on the wall. Components on the walls shall be identified as in the functional block diagrams

(f) Wiring Diagrams: Provide wiring diagrams showing all field installed interconnecting wiring. Wire identification on the diagrams shall agree with the wire markers installed on the equipment

(g) System Administrator Documentation: The Contractor shall supply three (3) hardcopies of administrator documentation and three (3) copies of the documentation in PDF format on CD-ROM that detail the operation of the system. This documentation shall provide complete information on the configuration, business rules, operation, maintenance, and trouble-shooting of the system

6 Warranty: The Contractor shall supply all warranties as required in the “Warranty” article of this specification.

54.3.4 General Testing Requirements

1 Phases of Testing:
   (a) Factory Acceptance Testing
   (b) Integration Testing
   (c) Endurance Testing

2 Project Testing: The system installation shall not be considered complete until On-Site Endurance Testing are completed. The purpose is to test the complete system and demonstrate that all specified features and performance criteria are met. All requirements of the specification shall be tested, including:
   (a) Functionality, including reporting and response
   (b) System capacity
   (c) Hardware and software interaction
   (d) Failure Recovery
   (e) Report generation

3 Test Plan/Procedure: Contractor shall provide six (6) copies of the proposed test plan/procedures for each testing phase for the review of the Engineer. The test
plan for each phase of testing shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The submission of Test Plans shall adhere to the following:

(a) A draft test plan shall be presented to the Engineer at least forty-five (45) days prior to the scheduled start of each test

(b) A workshop for reviewing comments shall be conducted with the Engineer at least thirty (30) days prior to the scheduled start of each test

(c) A final test plan shall be submitted to the Engineer at least fourteen (14) days prior to the scheduled start of each test

4 Test plans shall contain at a minimum:

(a) Functional procedures including use of any test or sample data

(b) Test equipment is to be identified by manufacturer and model including LAN analyzers and packet sniffers

(c) Interconnection of test equipment and steps of operation shall be defined

(d) Expected results required to comply with specifications

(e) Traceability matrix referencing Specification requirements with specific test procedures

(f) Record of test results with witness initials or signature and date performed

(g) Pass or fail evaluation with comments

5 The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.

6 All Test plans must be reviewed by the Engineer. To successfully complete a test, the test document must be signed and dated by both the Contractor and the Engineer.

7 The Engineer will review, witness and validate the execution of all formal test procedures prepared by the Contractor and deliverable under the contract to assure the tests cover all requirements and that there is a conformity between the conducted test, the test results and Specification requirements.

8 Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.

9 The Contractor shall provide the Employer or Employer representative the opportunity(s) to participate in any or all of tests.

10 Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Six (6) copies of the test report shall be submitted to the Employer representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:
(a) Commentary on test results
(b) A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution
(c) Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test
(d) Signatures of persons who performed and witnessed the test

Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to Employer. The problems identified in each phase shall be corrected and the percentage of the entire system re-tested determined by the Engineer before any subsequent testing phase is performed.

54.3.5 Factory Acceptance Testing

1 The purpose of this test is to validate that the individual systems components function as standalone equipment and all specified features are met.

2 The Contractor shall ensure that development of the system is complete, required approvals of submittals have been obtained, and sufficient equipment has been procured to completely demonstrate and test the system.

3 Factory Acceptance testing shall be completed at an Employer authorized test site.

4 Test Setup Equipment: Equipment shall be the actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting pre-delivery test:
   (a) Equipment associated with the system
   (b) Devices associated with system
   (c) Software associated with system
   (d) Administrative tools and equipment
   (e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

5 Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer authorized personnel.

6 Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

7 If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

8 Reporting:
   (a) Record all test procedures and results
   (b) Submit report in accordance with reporting requirements in General Testing
54.3.6 Integration Testing

1. The purpose of this test is to validate integration between the system and other interfaced subsystems or systems and to demonstrate that all specified features are met. All requirements of the LAN integration shall be tested including connectivity, interaction, interface, format, and data flow.

2. Integration testing shall be completed at the systems integration laboratory or other authorized location on-site at the campus. Interfaces may be tested using simulated data to/from other systems.

3. Test Setup Equipment: Equipment shall be actual products or identical models of products to those designated to be delivered and installed at the site. The following equipment shall be setup and used for conducting the test:
   (a) Equipment associated with the system
   (b) Devices associated with system
   (c) Software associated with system
   (d) Administrative tools and equipment
   (e) Sufficient data to provide accurate simulation of all potential permutations of operational conditions as required by design

4. Acceptance: Acceptance of system to perform sufficiently and provide specified functions shall be determined by the Engineer. Testing may be witnessed by additional Employer personnel.

5. Acceptance Criteria: Performance of system shall equal or exceed criteria stated in individual Specification Parts.

6. If system does not perform satisfactorily, the Contractor shall make corrections and modifications and schedule new test with the Engineer.

7. Reporting:
   (a) Record all test procedures and results
   (b) Submit report in accordance with reporting requirements in General Testing Requirements Part

54.3.7 Endurance Testing

1. The purpose of this test is to validate that the fully integrated system meets the Endurance and High Availability requirements.

2. Integration testing shall be completed on-site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf. All interfaces shall be tested using actual interfaces to other systems (i.e. no stubs or dummy data.)

3. Requirements:
   (a) Provide personnel to monitor system operations 24 hours per day, including
weekends and holidays during Endurance Testing

(b) Start test after:
   (i) Successful completion of Integration Testing
   (ii) Training as specified has been completed
   (iii) Correction of deficiencies has been completed
   (iv) Receipt of written start notification from the Engineer

(c) Monitor all systems during Endurance Testing. Coordinate monitoring with the Engineer

(d) Recording: Record data on forms so as to provide a continuous log of systems performance. Include:
   (i) Date and time for all entries
   (ii) Name of individual making entry
   (iii) Environmental conditions
   (iv) Activities in process
   (v) Description of all alarms, responses, corrective actions, and causes of alarms. Classify as to type of alarm
   (vi) Description of all equipment failures, including software errors
   (vii) Description of all maintenance and adjustment operations performed on system
   (viii) Daily and weekly tabulations
   (ix) Daily entries of performance data shall be reviewed by the Engineer

(e) Employer may terminate testing at any time when the system fails to perform as specified. Upon termination of testing the Contractor shall commence an assessment period as described in Stage II

4 Testing

(a) Stage I - Initial Phase Testing:
   (i) Time: 24 hours per day for 30 consecutive calendar days
   (ii) Make no repairs during this stage unless authorized in writing by the Engineer
   (iii) If system experiences no failures, proceed to Stage III - Final Testing

(b) Stage II - Initial Phase Assessment:
   (i) After conclusion of Stage I, or terminating of testing, identify all failures, determine causes, and repair. Submit report explaining: Nature of each failure, corrective action taken, results of tests performed to verify corrective action as being successful, and recommended point for resumption of testing
   (ii) After submission of report, schedule review meeting at job site. Schedule date and time with the Engineer
   (iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
(iv) Based on report and review meeting, the Engineer will direct Contractor to repeat Stage I, restart Stage I, or proceed to Stage III - Final Testing

(c) Stage III - Final Phase Testing:
(i) Time: 24 hours per day for 15 consecutive calendar days
(ii) Make no repairs during this stage unless authorized in writing by the Engineer

(d) Stage IV - Final Phase Assessment:
(i) After conclusion of Stage III or termination of testing, identify all failures, determine causes, and repair. Submit explaining the nature of each failure, corrective action taken, results of tests performed, and recommended point for resumption of testing
(ii) After submission of report schedule review meeting at job site. Schedule date and time with the Engineer
(iii) At review meeting, demonstrate that all failures have been corrected by performing verification tests
(iv) Based on report and review meeting, the Engineer will review Endurance Test or direct Contractor to repeat all or part of Stages III and IV

5 Adjustment, Correction, and Maintenance

(a) Adjustment and Correction: Make adjustments and corrections to system only after obtaining written approval of the Engineer
(b) Maintenance: Perform required maintenance on systems including provision of replacement parts

6 Final Inspection and Acceptance

(a) After Endurance Testing is complete, review tabulated records with the Engineer
(b) Contractor will not be responsible for failures caused by:
   (i) Outage of main power in excess of backup power capability provided that automatic initiation of all backup sources was accomplished and automatic shutdowns and restarts of systems performed as specified
   (ii) Failure of any Employer furnished power, communications, and control circuits provided failure not due to Contractor furnished equipment, installation, or software
   (iii) Failure of existing Employer equipment provided failure not due to Contractor furnished equipment, installation, or software
(c) When performance of system does not fall within the above parameters, determine cause of deficiencies, correct, and retest
(d) When requested by the Employer, extend monitoring period for a time as designated by the Employer
(e) Period shall not exceed 60 days exclusive of retesting periods caused by termination of Stages I or III and assessment period of Stages II and IV
(f) Submit final report of Endurance Testing containing all recorded data

54.3.8 Maintenance and Support

1 General

(a) The Contractor shall provide maintenance and support of all components associated with this system at no additional charge during the warranty period. This extends to systems requiring vendor pre-purchased maintenance agreements.

(b) The Contractor shall supply a list of special tools, test equipment, and outside inventory required for this Project. The Contractor may recommend specific items to facilitate long-term support of the system as an option to the Employer.

(c) All lead technicians performing installation and maintenance shall have a minimum of two (2) years experience on the proposed system and be manufacturer certified on all hardware/software applications. All maintenance technicians shall be provisioned to attend a one (1) week manufacturer training class each year. Pre-assigned backup technicians shall be available to backfill for onsite technicians who are on vacation, in training or who are out sick.

(d) The Contractor shall provide twenty-four (24) hours/seven (7) days a week telephone support as a minimum maintenance and support agreement. Additionally, the Contractor shall specify a maximum amount of time to get the system up and operational in the event of a system failure. This time period shall be subject to Engineer’s approval.

2 Hardware and Software Support

(a) Hardware and Software support shall be supplied by the Contractor directly or by a Sub-Contractor reviewed by the Employer. Support shall cover all equipment and systems referenced in this Specification.

(b) The Contractor shall assume full responsibility for the performance of all equipment supplied by the Employer, provided that such equipment meets the specifications set forth by the Contractor.

(c) All software shall be delivered with an installable backup.

3 Pricing after Warranty Period: Cost of maintenance and support on a yearly basis after the Warranty period has expired, shall be included as an option to be exercised by the Employer or his designated representative. Contractor shall clearly state in the bid the annual cost and availability of the following services that the Employer may wish to use or to continue after the initial Warranty period has expired (Costs shall be given for a three (3) years with additional two (2) years to be renewed on an annual basis):

(a) Costs of maintenance of the equipment and software

(b) Cost of software and firmware upgrades

(c) Telephone consultation support

(d) Technicians on-site (including travel, meals and lodging) to repair or replace malfunctioning equipment or software, if not covered in the
maintenance costs above
(e) Programming on message text, animation sequences, and the like for Employer use and operation

4 Definitions

(a) Preventive and Routine Maintenance: Preventive and routine maintenance services shall be provided in accordance with the provisions of the maintenance manual for each component. Preventative maintenance services shall include inspection, test, necessary adjustment, lubrication, parts cleaning, and upgrades. Routine maintenance services shall include scheduled overhauls as recommended by the equipment manufacturer.

(b) Emergency Failure: A system failure is considered an emergency if any of the key components are inoperative to the extent the system cannot function in a normal manner. Emergency services shall include inspections and necessary tests to determine the causes of equipment or software malfunction or failure. The emergency services shall include furnishing and installing components, parts, or software changes required to replace malfunctioning system elements. The Contractor shall provide telephone support twenty-four (24) hours a day, seven (7) days a week. The Contractor shall provide support on-site within eight (8) hours of request.

(c) Support: Support shall be supplied by the Contractor directly or by a sub-Contractor reviewed by the Employer. Support shall cover all equipment referenced in this specification.

54.3.9 Cleaning

1 Upon completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

54.3.10 Training

1 The User Training shall include on-the-job-training of at least two (2) weeks. The training shall be conducted on site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf or other campus location provided by the Employer.

2 The System Administrators Training shall include on-the-job training. Six (6) weeks of on-the-job training shall be provided. This training shall be conducted on site at the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf or other campus location provided by the Employer.

3 The Contractor shall provide the Employer specified trainees with detailed As-built information by the Contractor Lead Network Engineer. The training shall provide the system Administrators with a working knowledge of the system design and layout, and shall provide troubleshooting methods and techniques. In addition, the training shall cover testing, maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.

4 Course materials shall be delivered to the Employer. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the Employer. The Contractor shall supply a...
videotape of each training course.

5 All training shall be completed a minimum of two (2) weeks prior to the system becoming operational and utilized by the Employer. Training schedule subject to the Employer’s review.

54.3.11 Acceptance

1 The Contractor shall not apply power to the system until after:

(a) System and components have been installed and inspected in accordance with the manufacturer’s installation instructions

(b) A visual inspection of the system components has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections

(c) System wiring has been tested and verified as correctly connected as indicated

(d) All system grounding and transient protection systems have been verified as properly installed and connected, as indicated

(e) Power supplies to be connected to the system and equipment have been verified as the correct voltage, phasing, and frequency as indicated

2 Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3 Acceptance will be withheld until the following have been completed successfully:

(a) Acceptance of all submittals

(b) Successful testing and delivery of approved test results

(c) Completed Training as per the specifications as well as successful demonstration of the operation of the entire system

(d) Final cleanup of the system and work areas

        Delivery of all documentation including accepted As-built documentation.
Add the following completely new Part titled: Part 55 – Water Leakage Detection System:

55. WATER LEAKAGE DETECTION SYSTEM

55.1 GENERAL

55.1.1 Related Documents

1 Drawings and General Provisions of the Contract, including General Conditions, Conditions of Particular Application and Division-1 Specification Sections, apply to work of this Section.

55.1.2 Description of Work

1 Design, supply, install, test and commission complete water leakage detection and monitoring systems for all areas in the project which include water source, including all components, accessories and wiring to form complete system whether they shown or not, the system shall include but not limited to the monitor unit panel, leak sensors, equipment accessories, wiring and all necessary accessories to form a complete system as specified.

2 This document provides minimum technical specification / requirements for the Water Leak Detection System that shall be installed in the project as indicated in drawings and relevant documents.

3 The system shall be interfaced with BMS, the contractor shall include in the design and working drawings the method of interfacing of the system.

55.1.3 Reference Codes and Standards

1 All works shall be performed in strict accordance with the drawings, specifications and stipulations of the local codes and standards, the National Fire Protection Association (NFPA), International Electrical Commission (IEC), the Underwriters Laboratory (UL) Listing or other equivalent international standards.

2 Equipment and installations shall comply with the latest revision of the current provisions of the following codes, standards and regulations:

(a) Standards of local authorities having jurisdiction

(b) Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code"

(c) CCIR Compliance: Comply with the relevant CCIR standards or approved equal

(d) UL Compliance: Comply with requirements of UL 1023

(e) IEC Compliance: Comply with applicable requirement standards pertaining to system and wiring

3 An equal standard could be accepted, which should be listed in detail as an alternative. Such alternative standards shall be indicated in detail together with their equivalent IEC, IT-R, NFPA and UL.
55.1.4 Submittals

1 Submit the following in accordance with Conditions of the Contract and Division-1 Specification Sections:

(a) General: Submit the necessary complete sets of documentation indicating type, size, rating, style, catalog number, manufacturer’s names, photographs and/or catalog data sheets for all items to ensure compliance with Specifications. This documentation shall be subject to the approval of the Engineer and no equipment shall be ordered without his approval for all equipment and devices, which are shown on Drawings, Schedules and in Bill of Quantities.

(b) Shop Drawings: Provide shop drawings showing equipment and device locations and connecting wiring of entire system, including riser diagrams. Shop drawings shall include, but not be limited to, the following:

(i) Complete one-line riser diagram(s) showing all equipment and the size, type and number of all conductors including signal strengths and cable loss

(ii) Pin to pin connection diagram

(iii) Layout of water detection cable and location of Monitor unit.

(iv) Large scale drawing of control panel, and other devices

(v) Provide calculations to support the loss in cables and signal strengths of the different equipment, the size of wiring and signal loss.

(vi) Provide installation instructions and installation manuals

(vii) Complete description and data including UL listing, or equivalent, for all system components

(viii) Complete sequence of operations and functions of the system

(ix) Complete system wiring diagrams for components and interfaces to equipment provided by others

(x) A listing of the manufacturer’s authorized, local representative responsible for installation coordination and service

(c) Product Data: Submit manufacturer’s technical product data, including specifications and installations for each type of the equipment. Include standard or typical riser and wiring diagrams and operation and maintenance instructions for inclusion in the maintenance manual.

(d) Maintenance Data: Submit maintenance data and parts lists for each type of the system equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual in accordance with requirements of Division-1 and other relevant documentation.

55.1.5 Quality Assurance

1 Manufacturer Qualifications: Manufacturing firms of the system shall be regularly engaged in manufacturing of the system of type, size and characteristics similar to those required for the project and whose products have been in satisfactory service in similar projects for not less than five (5) years.
2 Installer Qualifications: Engage an experienced installer who is a factory-authorized sales and service representative to perform the work of this section.

3 The installer firm shall have at least five (5) years of successful installation experience of the systems similar to that required for the project.

55.1.6 Delivery, Storage and Handling

1 Deliver products in factory containers. Store in clean, dry, closed space in original containers. Protect products from fumes. Handle very carefully to avoid shocks or damage.

55.1.7 As-built Drawings

1 During the construction of the system, the Contractor shall put in writing all his remarks, during the progress of work, concerning any suggested alterations from the shop drawings in wiring routes, locations of equipment or devices which arise from coordination between the system and other activities.

2 No execution of alterations shall be allowed before receiving written approval from the Engineer.

3 All alterations shall be registered and filled by the Contractors and extra copies shall be submitted to the involved parties (Engineer, Project Manager, Site, etc.).

55.1.8 Spare parts

1 The Contractor shall provide the recommended spare parts for three years operation.

55.2 PRODUCTS

55.2.1 General

1 Water leak detection system shall be used in all areas in the project which include water source, as indicated on drawings. It shall be used to detect water leakage inside the room as indicated on drawings. The system shall be consists of monitor unit and sensor cable.

2 The Sensor cable shall be surrounding all water sources. The Monitor unit shall be connected to the BMS system to report the alarm and take the proper actions.

3 The System shall provide water leak detection and give the earliest warning of a leak from the ingress of water into areas through external walls, air-conditioning water pipes, etc.

4 The system shall provide an alarm giving an accurate location of a leak at a specific zone.

5 The system shall comprise a network of sensing devices connected to a locally mounted Monitor unit. The sensing device shall consist of water sensing cables that water / liquid must touch for an alarm to be activated.

6 The leak detection system will continuously monitor the network of sensing devices and give an alarm in the event of detecting a leak or system/sensing device malfunction, damage or disconnection.

7 The length and/or number of sensing cable or devices and their installation disposition shall be as recommended by the specialist sub-contractor.

8 The system shall be capable of reporting the location of a leak to a sufficiently accurate position to enable the operator to locate and identify the activated
section of detection cable quickly and accurately.

9 The Monitor unit shall be capable of providing the level of accuracy of leak detection required. This may be achieved by applying a continuous number of separately reporting zones of appropriate length. Wherever possible the allocation and installation of zones shall be arranged to coincide with defined areas or “land marks”, individual rooms, partition walls or other easily identifiable features. This is to facilitate speedy and positive leak location.

10 The sensing cable shall be constructed such that no metallic parts are exposed to the environment. The system shall include all components required for the specific installation.

11 The system shall sense the presence of a leak, locate the leak, sound an audible alarm and activate alarm output contacts, and provide RS-485 interface to the BMS system.

12 The system shall be supervised and self-diagnostic in design. The system shall differentiate between and supervisory alarm status, and shall locate point of required service.

13 The sensor cable shall encircle any water source throughout the coverage area. The sensor provides indication of ingress of water from external areas.

14 The Monitor unit shall indicate the name of the room and footage or zone number of any fluid detected at any point on the entire sensor system. The panel shall sound a local alarm, and provide digital and RS-485 outputs to the BMS system.

15 The monitor Unit provide system diagnostic to continually monitor all sensor systems for maintenance requirements such as low level contamination, continuity, ground fault, or electronic failure. The unit shall provide 1024 event data logging with non-volatile memory.

16 The locating alarm panel shall be capable of monitoring up to 1500 meter or 100 zones of sensing cable or sensing probes and to provide user interface up to 31 sensor interface modules. The unit shall continue to monitor all of the systems even after detecting and locating the leak or service event. The system shall re-alarm on movement of the first event or upon detection of subsequent events.

17 The unit shall provide cable diagnostics to indicate if maintenance on the sensor cables is required. The panel shall provide full system diagnostics on the detection and measurement circuitry. If the required service is due to contamination or electrical ground fault on any sensor the panel shall indicate both the magnitude and location of the contamination or the ground fault. The system shall continuously monitor the sensing cables and interconnecting cables for continuity.

18 The unit shall not require any operator programming and shall be capable of automatically calibrating the entire system including components when power is supplied.

19 The water sensing cable shall detect water with as little as two (2) wetted (non-immersed) inches in contact with the water, anywhere along it’s length, regardless of length. Systems without uniform sensitivity over the entire sensor length are not acceptable.

55.2.2 Equipment and Materials

1 System shall consist of (But not limited to):

   (a) Monitor Unit
   (b) Sensor Cable
(c) All needed accessories (Cable Clip, Cable Connector, Screw Terminal, etc.) for connection and fixation

2 Monitor Unit:

(a) Unit shall have

(i) Minimum 4 virtual zones
(ii) Simple installation and setup
(iii) LCD Display with backlight to indicate distance to leak location in meters and feet
(iv) 24V operation voltage
(v) Backup battery for 24 hour operation
(vi) LEDs for Power, Alarm and Fault status
(vii) Generate 85db Audible Sounder for Alarm and Fault
(viii) Two output relays (Alarm and fault)
(ix) One communication port (RS232, RS485, etc)
(x) 4-20mA and 0-10VDC analog outputs
(xi) UL, FM approved or equivalent
(xii) Maximum cable length 1,000 ft. (305m) at least
(xiii) Adjustable Leak/Delay to help prevent false alarms
(xiv) Response time 20-3600sec, software adjustable in 10sec increments; ±2sec
(xv) Can detect a leak anywhere along the length of cable
(xvi) Detection accuracy : 0.5m +/- 0.5%
(xvii) Interface with BMS through software interface

3 Sensor Cable:

(a) Water detection cable shall consist of 4 conductors, 2 water sensitive and 2 data, the conductors are individually insulated and protected with an outer covering of braided polypropylene.

(b) UL, FM approved or equivalent

(c) Length as indicated in drawings if not indicated cable should cover perimeter of the selected room

(d) The cable shall be restorable and corrosion resistant, and shall not require replacement after being wet

(e) Outside diameter : 6mm +/- 0.5mm

4 Grounding Considerations: Grounding systems are normally an integral part of the specific signal or communications cabling system that they protect. In addition to helping protect personnel and equipment from hazardous voltages, a proper grounding system may reduce EMI to inform the communications cabling system. Improper grounding can produce induced voltages and those voltages can disrupt other communications circuits.
The system shall include connection with the ground.

55.3 EXECUTION

55.3.1 Examination

1. Examine conditions, in the presence of the installer, for compliance with the requirements and other conditions affecting the performance of the system work.

2. Do not proceed until unsatisfactory conditions have been corrected.

55.3.2 Installation

1. General: Install systems in accordance with codes and standards. Install equipment and wiring in accordance with manufacturers' written instructions.

2. Appropriate measuring equipment shall be used (signal strength voltage, current, etc.), for the network adjustment and trouble shooting.

(a) Wiring Methods: Install wiring in raceway/conduit except within consoles, desks and counters, excepts in accessible ceiling plenums where cable wiring method may be used. Cables used in environmental air space shall be listed for this use. Conceal cables in accessible ceilings, walls and floors wherever possible.

(b) Surge Suppressors Installation: Where AC power-operated devices are not protected against voltage transients by integral surge suppressors, install surge suppressors at the devices' power line terminals.

(c) Wiring Method: Conceal cable in accessible ceilings, walls, and floors wherever possible.

(d) Wiring Within Enclosures: Bundle, lace, and train the conductors to terminal points with no excess. Provide and use placing bars and distribution spools.

(e) Pulling Cables: Do not exceed manufacturer's recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between indicated termination, tap, or junction points. Remove and discard cable where damaged during installation and replace it with new cable.

(f) Exposed Cable: Install parallel to building lines, follow surface contours, and support as recommended by manufacturer.

(g) Grounding: As recommended by manufacturers.

(h) Make final connection to equipment in the presence of the equipment manufacturer's representative.

3. Installation of the Equipment: The installation of this equipment shall cover the following:

(a) Installation of all central & distributed equipments

(b) Internal signal, power, and control wiring

(c) External signal, power, and control wiring related to the system

(d) Adjustment, testing and putting into operation of the equipment, and other related equipment to achieve the specified performance.

4. Installation of the Cable Network: The cable network shall include the communication, power, and control cables required for the whole system and
shall be installed taking into consideration the following:

(a) Laying the cables which shall connect the equipment including the installation of connectors, junction boxes, and matching/splitting units if exists.

(b) The installation shall include any necessary ground loop corrector.

(c) Installation of signal cables and control wiring of the equipment.

55.3.3 Testing

1 Contractor is required to test system each segment (5-10) meter according to cable length and room dimensions.

2 Results should be correct (length of alarm area) with suitable time response

3 At least test should be done on each wall of the room (or each segment of cable)

55.3.4 Field Quality Control

1 Manufacturers’ Field Services: Provide services of factory-authorized service representatives to supervise the field assembly and connection of components and system presetting, testing, and adjustment.

2 Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

3 Presetting: Align and adjust the system and pretest all components, wiring, and functions to verify they conform to specified requirements. Replace malfunctioning or damaged items with new items. Retest until achieving satisfactory performance schedule.

4 Operational Acceptance Tests: Perform operational system tests to verify it conforms to specifications. Include all modes of system operation. Methodically test for proper system operation in all functional modes.

55.3.5 Cleaning

1 Clean all system components. Use methods and materials recommended by manufacturer.

55.3.6 Adjustment

1 Occupancy Adjustments: When requested within 1 year of date of Substantial Completion, provide on-site assistance in adjusting the system to suit actual occupied conditions. Provide up till 2 requested adjustment periods at the site for this purpose without additional cost.

55.3.7 Training

1 The Contractor shall conduct training classes for the Employer personnel on the installation, maintenance, programming, and operation of the system including troubleshooting and problem tracing procedures. The training shall be on site for five (5) persons for duration of 5 days.
SECTION 22

AIR CONDITIONING, REFRIGERATION AND VENTILATION
1. GENERAL

1.1 INTRODUCTION

1.1.1 RELATED DOCUMENTS

1. The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2. Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3. Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

1.1.2 SCOPE

1. This Part details the requirements for air conditioning, refrigeration and ventilation systems. It shall apply to all mechanical and electrical systems and equipment.

2. Related Sections are as follows:

   - Section 1   General
   - Section 5   Concrete
   - Section 10  Instrumentation, Control and Automation
   - Section 16  Structural Metal Work
   - Section 17  Metal Work
   - Section 21  Electrical Installations

1.1.3 REFERENCES

1. Work shall be performed in strict accordance with the applicable requirements of the Qatar Standard specifications, latest edition, Local Standards and other International Standards as noted below:

   (a) ANSI: American national standards institute
   (b) ARI: Air-conditioning and refrigeration institute
   (c) ASHRAE: American society of heating, refrigerating and air conditioning engineers
   (d) ASME: American society of mechanical engineers
   (e) ASTM: American Society for testing and Materials
1.1.4 Standard of Work

1. The Contractor shall install equipment, air conditioning ducts, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the satisfaction of the Engineer. Air conditioning ducts and pipes shall be installed parallel and perpendicular to the building planes. All piping and ductwork shall be concealed in chases, behind furring, or above ceiling, except in unfinished areas. All exposed systems shall be installed neatly and be grouped to present a neat appearance.

2. All gauges, thermometers, etc., shall be installed in such a way as to facilitate easy observance.

3. All equipment and apparatus, which requires maintenance, adjustment or eventual replacement, shall be installed making due allowance for access.

4. Control sensors shall be installed to guarantee proper sensing. Elements shall be shielded from direct radiation and shall avoid being placed behind obstructions.

5. All panels and boards, etc., shall be installed to remit easy operation.

6. The Contractor shall include in the work all the requirements of the
manufacturer’s as shown on their drawings.

7 The Contractor shall replace all work not performed to the satisfaction of the Engineer without extra cost and to the standard required by the Engineer. This applies to any item that is found to be defective in service during the maintenance period, or extended maintenance period as appropriate.

8 Where height dimensions are given, the installation shall be reasonably expected to be within 13 mm of actual position.

9 Items displaying a horizontal dimension or edge must be plumbed with a level and must be to the Engineer’s satisfaction. Any apparent discrepancy between “level” electrical and mechanical items and adjacent items MUST be reported immediately to the Engineer.

10 All work shall be co-ordinated with other works so as not to obstruct equipment and apparatus which requires maintenance, adjustment or eventual replacement.

11 Manufacturers and subcontractors shall operate an ISO 9000 approved quality system or equivalent in house system. If requested, details of the quality system shall be submitted to the engineer.

12 Equipment shall conform to the requirements of the Project Documentation and reference standards.

13 All equipment furnished shall be new, and where feasible shall be a standard product of an experienced or approved manufacturer, and assembled from standard components readily available.

14 The submitted drawings are assumed to represent a complete detailed and coordinated design. The contractor shall be responsible for providing a complete installation, coordination with other trades and coordination with field conditions.

15 Schematic diagrams generally indicate equipment connections to be used for various systems. Provide all work shown on diagrams whether or not it is duplicated on plans.

16 Except where modified by a specific notation to the contrary, the indication and/or description of any item in the Drawings or specification or both carries with the instruction to furnish and install the items complete with all appurtenances of whether or not this instruction is explicitly stated as part of the indication or description.

17 Drawings out of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installation. Install the work in accordance with the diagrammatic intent expressed on the electrical and mechanical Drawings and in conformity with the dimensions indicated on final architectural and structural working Drawings and on equipment shop Drawing.
18 Certain details appear on the Drawings which are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work.

19 Derive information as to the general construction from structural and architectural Drawings and specifications.

20 Definitions: Where used in these document and accompanying drawings, the following words are defined as listed:

(a) "Provide" to furnish, install and connect up complete and set to work ready for safe and regular operation of particular work referred to.

(b) "Install" to erect, mount and connect up complete with related accessories and set to work ready for safe and regular operation of particular work referred to.

(c) "Furnish" or supply to purchase procure acquire and deliver complete with related accessories.

(d) "Work" labour, material, equipment, apparatus, controls, accessories and all other items required for proper and complete installation.

(e) "Concealed" embedded in masonry or other construction installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

(f) "Exposed" not installed underground or concealed as defined above.

(g) "Indicated" "shown" or "noted" as indicated, show or noted on drawings or specifications.

(h) "Similar" or “equal” of base bid manufacturer, equal in materials, weight, size, design and efficiency of specified product conforming to "Base bid Manufacturer's".

(i) “Reviewed”, “satisfactory”, “accepted” or “directed” “approved” as reviewed, satisfactory, accepted, or directed by or to Architect.

(j) "Architect", “project Manager”, “owner” the party or parties responsible for interpreting, accepting and otherwise ruling on the performance under “This Contract”.

(k) “Contract” the agreement covering the work to be performed by “This contractor”.

(l) “The specifications”, “The section, part, Division of the Specifications” the documents specifying the work to be performed by "The Contractor”.

(m) “Other”, “other Trade” persons, parties or trades responsible for work of the project other than the parties who have been awarded the contract for this division of the work.
(n) “Operator” The party or organization appointed by the Owner to provide around the clock, 365 day operation of this facility.

(o) “The contractor” The organization awarded responsibility for delivering a complete approved and operable project.

(p) “Acceptable Manufacturer” The manufacturer whose product meets the full conditions of the contract documents in quality, aesthetic, appearance, capacities, ratings, applicable codes, space allocation and warranties to the specified as approved by the Architect.

1.1.5 Data to be Supplied with Tender

1 Initial technical submissions are to accompany the bid including full technical details of every item of equipment proposed for the Project, with the appropriate figures and details highlighted in marker pen or similar in standard manufacturer’s catalogues.

2 After final checking of sizing after award of contract, re-submission shall be made with any changes specifically noted.

3 Technical submissions shall be submitted for all equipment as specified in the Project Documentation.

4 In the event that the Engineer requires further information on any of the proposed items the Contractor shall arrange visits to similar units that he has installed. In an event, all equipment proposed for the Project shall be currently installed and working satisfactorily locally. The Contractor must be able to provide references of at least three satisfied Owners and Engineer with equipment of the particular size and model proposed.

1.1.6 Practical Completion Certificate

1 A Practical Completion Certificate for works included in this Section shall only be issued when the Engineer is satisfied that all the requirements of this Section have been met.

1.1.7 Air Conditioning Subcontractor Scope of work

1 The specifications and the accompanying drawings are intended to secure the provisions of all material, labour, equipment and services necessary to install complete, tested, and ready for operation and set to work the HVAC Systems in accordance with the specifications and Drawings. Provide all systems complete with necessary appurtenances and minor auxiliaries, including offsets to clear interference and supports that are not shown on but are needed to make each system complete in every respect. Provide all work described in the specifications and not shown on the Drawings, or vice versa, in complete working order. If mention has been omitted of any item of work or material necessary for completion of the system then such items must be hereby included.
2 The air conditioning services subcontractor shall be responsible for co-ordination with other trades and services and shall provide all materials, labour and supervision, equipment, tools, appliances, services, etc. for the supply and installation of the following items or work:

(a) Air conditioning and ventilation plant and equipment.
(b) Sheet metal ductwork complete with air terminals, dampers, supports, etc.
(c) Controls and control panels
(d) Motor control centres and starter panels complete with cabling from the panels to the respective equipment. Power supply up to the panel shall be the responsibility of the electrical subcontractor.
(e) Insulated drain piping from each air handling unit, fan coil unit ... etc to the nearest drain point. The drainage subcontractor shall be responsible for provision of a floor drain in each mechanical room location to be co-ordinated with air handling units (AHU).
(f) Control wiring and control panels
(g) Safety devices, vibration isolation ...etc.
(h) Smoke fans, supply fans and exhaust fans
(i) A.H.U’S
(j) Air distribution systems consisting of all items indicated on the drawings and/or specified herein, such as:
(k) Grilles, registers, ceiling outlets, duct insulation, fire dampers, smoke dampers, airflow metering devices, etc.
(l) Acoustical treatments of ducts
(m) Sound absorbing sections
(n) Automatic temperature control systems consisting of all items indicated on the Drawings and/or specified herein such as:
(o) Various relays
(p) Ventilating systems consisting of all items indicated on the Drawings and/or specified herein:
(q) Supply fans
(r) Electric switch boards and wiring consisting of all items indicated on the Drawings and/or specified herein, such as:
(s) Protection and measuring instruments
(t) Wiring
(u) Earthling
(v) Furnishing of shop Drawings and brochures

(w) Furnishing of record Drawings

Balancing and adjusting of mechanical systems as specified herein.

Furnishing of operating and maintenance books.

Miscellaneous items as required for complete and functioning systems as specified herein and as indicated on the Drawings.

All system equipment and services specified herein shall be furnished and installed complete and ready for use.

3 The contractor shall also include all overheads at office and site, labour, sundries, plant, appliances and consumable both for the Works and for testing and commissioning, and during the maintenance period.

4 The air conditioning subcontractor shall be approved so as to meet all QGEWC regulations.

5 Provide all labour, materials, tools, machinery, equipment, appliances and services necessary to complete the HVAC work under this contract, coordinate the HVAC work with the work of other trades so as to resolve conflicts without impeding job progress. This includes:

(a) Operation and service of the whole system for 365 days, 24 hours a day. This period starts from the day of the handover of the project. This shall be done with no extra cost to the project

(b) Maintenance and the required spare parts during the guarantee period with no extra cost to the project

(c) Training of the owner staff to the satisfaction of the engineer

6 The work to be performed is construction and erection of HVAC work includes but is not limited to the mentioned systems.

7 Work not Included: The following items of work shall be under other trades and shall not be included as work under this trade:

(a) Electric supply points, through disconnecting switch as shown on the Drawings.

(b) Water and drain points as shown on the Drawings.

1.1.8 Design Data

1 Design parameters. Design, in general, shall be based on ASHRAE recommendation in addition to the following particular requirements:
2 Design conditions

Design in general shall be based on ASHRAE recommendation with the following particular requirements:

(a) External Design Conditions:
Design of the HVAC system shall be based on the following external environmental conditions:

- **Summer** 46°C db (Dry bulb temperature) at 30°C wb (Wet bulb temperature).
- **Winter** 10°C db (Dry bulb temperature) at 90% R.H. (Relative Humidity).
- **Daily Range** 10.8 °C

It should be noted that equipment shall be specified to perform according to design duty based upon the above condition. The equipment will be expected to run with a reduced performance up to 55 °C db (Dry bulb temperature) and in extremely humid environments of 100% RH (Relative Humidity) without failure.

(b) Site Geographical Data:
- **Latitude** 25.0 ºN
- **Longitude** 51.6 ºE
- **Altitude** 9.8 m above mean sea level

(c) Internal Design Conditions:

The building services elements and HVAC system shall be designed based on using the following internal environmental conditions:

<table>
<thead>
<tr>
<th>Space</th>
<th>Summer Max Temp °C</th>
<th>R.H.%</th>
<th>Noise Rating NR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examination</td>
<td>23</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>Lab</td>
<td>23</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>Offices</td>
<td>23</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>Meeting Room</td>
<td>23</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Prayer Room</td>
<td>23</td>
<td>50</td>
<td>25-30</td>
</tr>
<tr>
<td>Toilets</td>
<td>27</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Pantry</td>
<td>24</td>
<td>NC</td>
<td>40</td>
</tr>
<tr>
<td>Space</td>
<td>Summer Max Temp °C</td>
<td>R.H.%</td>
<td>Noise Rating NR</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------------</td>
<td>-------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Control Room</td>
<td>21</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>Telecom Room ICT/ELV</td>
<td>21</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>Changing rooms, Showers, lockers</td>
<td>24</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Cafe</td>
<td>23</td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td>Entrance lobby/Reception area</td>
<td>23</td>
<td>NC</td>
<td>40</td>
</tr>
<tr>
<td>Restaurant</td>
<td>23</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Pantry</td>
<td>24</td>
<td>50</td>
<td>45</td>
</tr>
<tr>
<td>ELEC Room</td>
<td>28</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>LV Room / UPS Room</td>
<td>24</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Battery Room</td>
<td>26</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>Gym</td>
<td>23</td>
<td>50</td>
<td>35</td>
</tr>
</tbody>
</table>

**Note:**

NC: No control.

RH. is design criteria not be controlled.

**Note:**

Inside design conditions will be calculated according to ASHRAE Handbook – HVAC Applications.

Relative humidity mentioned is for design cooling load calculations only, no direct control is used. Only for computer data centre rooms and rooms sensitive to static charges direct relative humidity control techniques shall be used.

Load calculations shall be based on 50% RH.

NC: No control, Refer to each building design conditions.

3 Fresh air supply: as indicated on the equipment schedules.

4 Noise levels:

In general, refer to design and contract documents.

5 Air Filtration
(a) Based on ASHRAE 52.1

6 Air Distribution

(a) Duct Velocity, supply : as per ASHRAE standards.
(b) Duct Velocity, return : as per ASHRAE standards
(c) Duct Velocity, Kitchen exhaust : as per ASHRAE standards

7 Contractor shall submit to both design engineer and site engineer all equipment and document that deviate from project specifications related to QSAS requirement certifications.

8 Contractor shall modified construction effect related to QSAS certificate without any extra cost that deviate from project specifications and not approved from both design engineer and site engineer.

1.1.9 Rating for Continuous Service and Local Ambient Condition

1 The Works shall be designed to facilitate inspection, cleaning, and ease of maintenance and operation in which continuity of service and reliability is the primary consideration. The design shall incorporate every reasonable precaution and provision for the safety of all concerned in the operation and maintenance of the plant.

2 All plant and equipment shall be suitable for operation under the prevailing ambient conditions at site and all special requirements for thermal insulation, finish, painting and lubrication etc. shall be incorporated.

3 Except where otherwise stated, all equipment shall be constructed and sealed as to prevent damage by the ingress of windblown sand and other matter. All equipment shall be suitable for operation over the ambient temperature range 0 °C to 55 °C.

4 Except where otherwise stated in the Project Documentation, the declared ratings for all equipment shall be for continuous operation in final service position for the following environmental criteria.

(a) Maximum daily average ambient temperature of 50 °C.
(b) Relative humidity of 90 %.
(c) Altitude 10.5 m above sea level.

These criteria shall be achieved independently of any forced means of mechanical ventilation or air conditioning plant.

1.1.10 Quality of Materials and Equipment

1 Provide equipment and materials required for installation under the specifications
new and without blemish or defect. Provide equipment and materials which meet with the acceptance of authorities having jurisdiction over the work. Where such acceptance is contingent upon having the products certified by a testing laboratory, provide products so listed or labeled. Where no specific indication as to the type or quality of material or equipment is indicated, furnish a first class standard article. Obtain approval of all manufacturers from the Engineer and Owner.

2 Wherever a manufacturer of a product is specified and the terms "other approved" or "approved equal" or "similar to" are used, the substituted item must conform in all respects to the specified item and meet with the Engineer's approval. Consideration shall not be given to claims that the substituted item meets the performance requirements with lesser construction. Performance as delineated in schedules and in the specifications indicate minimum performance. In many cases, equipment is oversized to allow for pick-up loads, de-rating and future loads which cannot be delineated under the minimum performance.

3 Provide all equipment of one type (such as valves, fans, pumps, coils, etc.) produced by one manufacturer.

4 Substituted equipment where permitted and approved must conform to space requirements. Replace at contractor's expense any substituted equipment that cannot meet space requirements. Whether approved or not. Make any modification of related systems as a result of substitution at contractor's expense.

5 Note that shop drawings, or other information submitted in accordance with the requirements herein specified, do not assure that the Engineer, attests to the dimensional suitability of the material or equipment involved. Engineer's failure to object to shop drawings does not invalidate the Drawings and specifications if in conflict.

6 Substitutions of equipment for that listed on the schedules or designated by model number in the specifications shall not be considered if item listed or described is not a regular catalogue item shown in the current catalogue of the manufacturer and been successfully used for a period of not less than five years.

1.1.11 Cleaning

1 Each day as the work proceeds, and on completion, the Contractor shall clean up and remove from the premises all rubbish, surplus material, equipment, machinery, tools, scaffolds, and other items used in the performance of the work. The Contractor shall clean out dirt and debris and leave the buildings broom clean with no stains and in a condition acceptable to the Engineer.

2 Where electrical items form part of the visible finish in the rooms, the Contractor shall protect them from over-painting, etc. and shall give all items a final cleaning before handing over.
1.1.12 Accessibility

1. Each item of equipment shall be located so as to be accessible for maintenance or repair without removing adjacent structures, equipment, piping, ducts, or other ducts, or other materials. For large air handling units the Contractor shall ensure that these can be assembled on site from components taken into the area.

2. Clean outs shall be located to permit rodding of all drain lines. These shall be located wherever possible external to occupied areas, and to minimise spillage problems during rodding.

1.1.13 Cutting and Patching

1. The Contractor shall inform all other Divisions in time concerning required openings. Obtain the approval of the Engineer before doing any cutting.

2. In existing work and in work already finished as part of this contract, all cutting and patching will be carried out at the expense of this Contractor. Where finishing work is involved, this will only be reinstated by the Contractor responsible for the original work. The Contractor shall obtain the approval of the Engineer before doing any cutting. Supporting members of any floor, wall or the building structure shall only be cut and in such a manner as approved by the Engineer. All reinstatement work must be done to the same standard as the original work.

1.1.14 Inserts, Sleeves, Escutcheons and Curbs.

1. The Contractor shall use only factory made, threaded or toggle type inserts as required for supports and anchors, properly sized for the load to be carried. The inserts shall be placed only in portions of the main structure and not in any finishing material.

2. The Contractor shall use factory made expansion shields where inserts cannot be placed, but only where approved by the Engineer and for light weights.

3. The Contractor shall not use powder activated tools except with the written permission of the Engineer.

4. The Contractor shall supply and locate all inserts, holes anchor bolts, and sleeves in good time when walls, floors, and roof are erected.

5. The Contractor shall ensure that insulation is unbroken where pipe or duct is insulated. Size sleeves shall be sized to provide adequate clearance all around.

6. The following materials shall be used for pipe sleeves:

   (a) through all interior walls above grade, standard weight galvanized steel pipes, machine cut, flush with finished structure. The Contractor shall check the room finishes schedules.

   (b) through all exterior walls above grade, standard weight galvanized steel
pipes machine cut, flush with finished structure inside and to suit flashing on outside

(c) through all exterior walls below grade and all other waterproof wall use extra heavy weight cast iron sleeves, machine cut. Refer to Section 14, Roofing, for further details.

d) through all waterproof floors, janitor's closets, mechanical rooms kitchens, roofs, use extra heavy weight cast iron sleeves, machine cut. As an alternative, copper DWV sleeves up to and including 150 mm sleeve size and rolled 10 kg/m2 copper sleeves for larger than 150 mm may be used. The sleeves shall be extended 100 mm above finished floor level upwards and cut flush with underside of floor. The Contractor shall make particular reference to flashing details through waterproof floors

e) approved type plastic sleeves may be used as an alternative for standard weight galvanized sleeves in interior areas if approved in writing by the Engineer

(f) the Contractor shall provide 100 mm high, 100 mm wide watertight concrete curbs with 20 mm chamfered edges around all pipes passing though waterproof floors except where furred in. Concrete works shall be done in accordance with Section 5, Concrete.

7 The Contractor shall pack all sleeves between the insulated pipe and the sleeve or where uninsulated between the pipe and the sleeve with polyurethane insulation. Seal the annular space as follows:

(a) for all horizontal sleeves in exposed areas, the Contractor shall use a seal equal or better fire rated than the wall to be sealed

(b) for horizontal concealed sleeves through fire walls and through walls separating areas of different air pressure, use a permanently resilient silicone based sealing compound.

(c) for all vertical sleeves through roofs, janitor's closets, equipment rooms, use permanently resilient silicone based sealing compound, non-inflammable and waterproof.

8 The Contractor shall ensure that the seal is compatible with the floor and ceiling finishes. The room finishing schedules shall be checked for further details and clarified if necessary with the Engineer.

9 The following sleeving shall be used for ducts: The minimum thickness of duct material passing through a sleeve shall be 1.3 mm. For rectangular duct openings through walls and floors a removable hardwood box-out shall be provided of the required size, soft wood or plywood will not be acceptable. Through fire walls, build fire dampers into wall, or make detailed fixing in accordance with Engineer’s instruction. Through floors where ducts are not furred in or enclosed in a duct shaft, provide 100 mm high and 100 mm wide watertight
concrete curbs, with 25 mm chamfered edges all around. Extend sleeves where used flush to top of curb. Concrete works shall be done in accordance with Section 5, Concrete. Through floors where duct is enclosed in a duct shaft or furred in, provide the watertight curbs at the extreme top and bottom only. Cover exposed floor and wall pipe sleeves in finished areas with satin finish chrome or nickel plated solid brass or with satin finished stainless steel escutcheons with non-ferrous set screws. Split cast plates of the screw locking type may not be used. Do not use stamped steel friction type split plates. Through roofs, provide curbs and sleeves as shown on drawings and to suit flashing requirements.

10 After ducts are installed, the openings shall be packed and sealed as follows:-

(a) fibreglass insulation for packing except through curbed concrete floors where a fibre proof packing must be used

(b) fibre proof packing shall be sealed in openings through floors with permanently resilient silicone base non inflammable waterproof compound; duct supports shall be pressed firmly down into caulking before bolting it down to curb

(c) through all vertical walls, seal the fibreglass packing using permanently resilient silicone based sealant.

11 Duct sleeves and box-outs shall be braced to retain their position and shape during the pouring of concrete and other work.

12 Bracing for each duct at ever passage through structure shall be provided to prevent sagging.

13 Exposed duct sleeves and openings shall be covered in exposed areas. 100 mm long galvanized steel escutcheons shall be used in the form of a duct collar. Over curbs, the collar shall be extended 30 mm down the side of the curb, similar to counter flashing. The collar shall be fixed in place with Cadmium plated screws.

1.1.15 Access Panels and Doors

1 The Contractor shall install all concealed mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels. Indicate access panels on as-built drawings.

2 The Contractor shall prepare drawings showing the location and type of all access doors in co-ordination with other trades before proceeding with installation and hand these to the Engineer to obtain approval. On smaller Projects, the Contractor shall indicate on the ceiling plans access required at the discretion of the engineer.

3 All access doors shall be sized to provide adequate access commensurate with the type of structure and architectural finish. Should it be necessary for persons to enter, a minimum opening of 600 x 450 mm shall be provided.
4 Proper fire rating of access doors shall be ensured in fire separations.

5 Lay-in type ceiling tiles, if properly marked may serve as access panels.

6 The Contractor shall provide panels in glazed tile walls of 2.6 mm thick 304 alloy stainless steel, with no. 4 finish, with the recessed frame secured with stainless steel, countersunk, flush-headed screws.

7 Panels in plaster surfaces shall be provided with dish shaped door and welded metal lath, ready to take plaster. A plastic grommet shall be provided for door key access.

8 Details of other types of access doors shall be submitted to the Engineer for approval.

1.1.16 Flashing

1 The Contractor shall provide flashing to all mechanical and electrical parts passing through or built into a roof, outside wall, or waterproof floor.

2 49 kg/m² sheet lead flashing shall be provided for cast iron sleeves passing through roof. Factory manufactured flange plates shall be provided to flash PVC-U pipes passing through roofs.

3 7 kg/m² copper flashing shall be provided for copper sleeves passing through roof where copper sleeves are used for copper pipe work.

4 All flashing shall suit the roof angle and shall extend a minimum of 400 mm on all sides. The Contractor shall build the flashing into the roofing system to render a completely watertight connection.

5 Counter flashing shall be provided on all stacks, ducts, and pipes passing through roofs to fit over the flashing or curb.

6 Pipes through waterproof floors shall be flashed as per approved details.

7 Provide pipes and sleeves passing through outside walls with lead or copper flashings and as directed by the Engineer. All visual aspects of such sleeves to be approved by the Engineer. All sleeves shall be installed according to the relevant standard and shall be suitable for local ambient conditions.

8 The Contractor shall pay special attention to the waterproof conditions of basements and walls and floors that may exist. The Contractor shall ensure coordination at all times with the waterproofing trade to prevent damage to any waterproofing seal. The Contractor shall provide piping sleeves passing through waterproof walls which shall be sealed to the satisfaction of the Engineer.

1.1.17 General Welding Requirements

1 All welding shall be generally in accordance with BS 4515. This will be modified
where appropriate for other materials and may be relaxed or varied by order of the Engineer, provided that the Contractor has made a comprehensive request for an alternate.

2 Tack welds shall be performed by fully qualified welders and all tack welds shall be of a length equal to twice the pipe thickness and shall fully penetrate the pipe walls.

3 Where welding is carried out in the proximity of inflammable materials special precautions shall be taken to prevent risk of fire or other damage to the building fabric.

4 Where oxyacetylene cutting equipment or any welding plant is being used by an operative for any part of the Works, then fire extinguishers shall be supplied and carried as part of the equipment. The operators of cutting and welding equipment shall be trained in the use of the fire extinguishers which they carry and all extinguishers shall be fully charged and ready for use. In all cases, extinguishers shall be positioned immediately adjacent to the position where cutting and welding is being carried out and shall be readily accessible for use in the event of an emergency.

5 All accommodation, benches, tools, welding plant, acetylene, oxygen or electricity, filler rods and electrodes, which are necessary for installations where welding is required, shall be provided as part of this Contract.

6 All welded pipe assemblies shall be constructed so that individual welded joints do not affect each other. The distance between the centres of adjacent welds shall be not less than twice the bore diameter of the pipe.

7 No welded joints shall be left partially completed. Any joints tacked in position must be promptly finished within the working day. The Engineer will reject all work not done in accordance with this instruction.

8 Where work is rejected, pipes must be machine cut at least 150 mm either side of rejected welds and proper weld preparation must be used on the shortened sector. Where shorter fill-in sections are required because of such rejection and re-working, then new full sized lengths must be supplied by the Contractor.

9 Where pipes with longitudinal seams are specified, pipes seams shall be arranged such that adjacent seams are opposed 45° from each side of top dead centre and branches shall be made only with weldable fittings.

10 All filler metals that are coated shall be protected from excessive moisture changes. Filler materials or fluxes that show any sign of deterioration shall not be used. If instructed by the Engineer, samples of filler rods to be used shall be submitted for approval before any work is done on site. These may be submitted, at the Contractor’s cost, to an independent testing laboratory for verification.
1.1.18 Testing for Welder Qualification

1 The purpose of the welder’s qualification tests is to determine the ability of the welders to make sound and acceptable welds. Before any site welding on the contract is allowed, each proposed welder shall carry out the tests required in the presence of the Engineer.

2 A responsible person shall keep any weld test specimens that have been suitably marked and approved on site, so that they can be produced at any time, at the request of the Engineer.

3 All accommodation, benches, tools, welding plant, acetylene, oxygen, electricity, test pieces, filler rods, electrodes, facilities for cutting and grinding, polishing, bending and examining, which are necessary for welders qualification tests shall be provided by the Contractor. In the absence of any items for inspecting the welds, the Engineer may submit the finished samples to an independent laboratory for testing at the Contractor’s expense.

4 Under no circumstances shall a welder be employed on the Works, either on or off the site, for welding operations other than those for which that welder is qualified.

5 Copies and records of all test reports shall be promptly given to and kept by the Engineer.

6 For tests for Qualification on Steel Pipes, each test shall be carried out in accordance with the test procedures laid down in BS 2640 and BS 2971. The test position shall be similar to the working conditions expected to be encountered and test pieces shall not be rotated to suit any individual welding procedures. Each test sample shall be subjected to the following examinations and test.

   (a) Pipes up to 100 mm diameter shall undergo visual examination and normal tongue bend test and X-ray test

   (b) Pipes over 100 mm diameter shall undergo visual examination and 2 normal tongue bend tests and two reverse bend tests and X-ray tests.

7 The Engineer may at his discretion require macro-etch examination in the event of any doubt. For a successful test, the weld shall conform in all respect to the requirements of the relevant British Standard. Each welder who qualifies shall be issued with a metal punch with an identifying number and shall stamp adjacent to each weld. If any test sample does not reach the required standard, two further welds shall be made and tested as detailed. Both of the re-tests shall be successful for the welder to qualify for the work.

8 For testing for Qualification on Copper Pipes, each test shall be carried out in accordance with the test procedures laid down in BS 1724. The test position shall be similar to the working conditions expected to be encountered and test pieces shall not be rotated to suit any individual welding procedure. Each test sample shall be subjected to the following tests and examinations.
(a) visual
(b) flattening test
(c) micro examination

9 For a successful test, the weld shall conform in all respects to the requirements laid down in BS 4515. Other conditions are similar to the above for steel pipes.

1.1.19 Testing of Welded Pipe work Installation

1 Testing of welded pipe work installations shall be by either destructive or non-destructive test methods as detailed in the following schedules.

2 All services 75 mm and below shall have two joints per floor for destructive testing. All services above 75 mm shall have two joints per floors for non-destructive testing. If a weld fails the testing requirements, then two additional welds made by the same operative shall be tested, at no additional cost. If both additional welds are successful, then in the case of destructive testing, the cost of making good shall be at no additional cost. If either of the two additional welds fail the test requirements, then further tests on other or all of the welds made by that operative shall be carried out, at the Engineer’s discretion. All costs resulting from either of the two additional welds failing the test requirements shall be at no cost to the Contract. If either of the two additional welds fail, then the operative concerned shall not make any further welds on any service unless approved by the Engineer.

3 The detailed requirements concerning testing shall be as follows:

(a) destructive testing. Destructive testing and examination shall be exactly as detailed under Tests for Welder Qualification

(b) non-destructive testing shall consist of radiographic inspection to comply with BS 2600 and BS 2910. Non-destructive testing shall be carried out by a specialist company approved by the Engineer

(c) the specialist company shall provide a report on the radiographic tests which have been made, including an interpretative results section. The report and films shall be handed to the Engineer

(d) the material of the image quality indicator shall be radio-graphically similar to that of the filler metal under examination

(e) the use of x-ray and gamma radiation sources shall be in strict accordance with the requirements of the Ionising Radiation (Sealed Sources) Regulations.

(f) the required radiographic sensitivity shall not be more than two, and the required image details shall be readily seen on each radiograph

(g) radiographs which do not comply with this requirement, whatever the cause, shall be unacceptable and the weld in question shall be re-
examined at no cost to the Contract. All interested parties shall be advised well in advance where and when radiographic tests are to be conducted, in order that appropriate precautions may be taken

(h) macro-examinations. When the Engineer requires macro examinations, these shall be carried out by a specialist company who shall present etched section photographs and a report on the tests to the Engineer. All costs for these tests are to be borne by the Contractor.

1.1.20 Painting, Tags, Name Plate Identification and Colour Coding

1 All painting of plant, equipment, storage vessels, and the like, and all surfaces to be painted in the areas where such items are installed, including generator areas, condenser areas, etc. shall be carried out by an approved specialist painting contractor.

2 Painting shall be applied to all pipe work and associated pipe work components, valves, fittings, etc. equipment, supports of any kind, insulation, plain mild steel, copper, or cast iron surfaces. Where movement is required between adjacent surfaces, the Contractor shall request clarification from the Engineer.

3 All surfaces to be painted shall be prepared by thoroughly cleaning and removing all rust, grease, oil, dirt and surface corrosion, using wire brush, emery paper and/or degreasing medium as required. The paint shall be applied in accordance with the manufacturer’s instructions and the type of paint to be used shall be in accordance with the following:-

(a) ferrous surface, one coat of zinc chromate primer plus wash primer as necessary, followed by 2 undercoats, and one finishing coat.

(b) non-ferrous surface, one coat of zinc chromate primer plus wash primers as necessary, followed by 2 undercoats, and one finishing coat.

Approved manufacturers shall supply all paint.

4 For factory applied finishes, repainting or refinishing of any surfaces damaged during shipping, erection or construction shall be done using only factory supplied materials.

5 After finished painting is completed, each piped and ducted service shall be identified, and identification and flow arrows located.

(a) behind each access door

(b) at each change of direction on all joining pipes and ducts

(c) at not more than 10 m in straight runs of exposed pipes and ducts, but on both sides of sleeves

(d) at not more than 10m apart in straight runs of pipes and ducts behind removal enclosures such as lay-in ceiling but on both sides of sleeves
(e) above each floor or platform for vertical exposed pipes, preferably 1.5m above floor or platform level.

6 PVC tape identifying bands will not be accepted.

7 Stencils and stencil paint shall be used on all piping and ductwork. Letters a minimum of 30 mm high shall be used. After completion of the Works, the Contractor shall provide to the Engineer usable stencils for each service.

8 Wherever insulation is to be painted, the paint used shall comply with all the fire resistance requirements for insulation finish, and shall be carried out by the insulation subcontractor. In all cases, the actual grade of paint to be used shall be suitable for the operating surface temperature and shall be approved by the maker for the application concerned. In certain cases, the grade of finishing coat may not require the application of undercoats in which case these may be omitted, provided that the Engineer’s approval in writing is obtained beforehand. All insulated or un-insulated pipework in concealed positions shall be identified by means of 75 mm wide identification bands, painted neatly on and at right angles to the pipe axis at intervals not greater than 3 m. In addition to the name of the service and pipe diameter shall be stencilled on in a visible position with an arrow indicating the direction of flow. Flow and returns shall have the letter “F” or “R” added to the identifying name. The identifying band colours and the finishing colour of the services to be painted shall be in accordance with the colours and procedures given in BS 1710. Ductwork shall be identified in accordance with the procedures laid down in HVAC Code of Practice No. DW 144.

9 All equipment located in concealed positions shall have a nameplate secured to the item giving the following information.

   Equipment reference number (as indicated on the record drawings).
   System
   Room/Area served
   Duty/output information

10 The name plate shall be 100 x 100 mm approximately, of white plastic 3 mm thick with the above information engraved in black lettering and the plate shall be secured by screws, bolts, clips, etc. as appropriate to the item concerned. This plate is in addition to any name plate supplied by the manufacturer of the item giving detailed specification information for the equipment.

1.1.21 Contract Drawings

1 The drawings included in the Project Documentation are diagrammatic, and intended to convey the scope of work and indicate general arrangement and approximate locations of apparatus, fixtures, pipe and duct runs, etc. The drawings are not intended to indicate Architectural or Structural details, nor do they show any fabrication or installation details.
2. Do not scale drawings. Obtain accurate dimensions to structure and architectural items from drawings of those trades. Confirm by site measurement. The Contractor shall verify the location and elevation of all services (water, electrical, telephone, sanitary, storm drainage, gas, etc.) before proceeding with the work.

3. The Contractor shall install all ceiling mounted components (diffusers, grilles, and detectors, light fixtures, emergency lights, fire detectors, loudspeakers, camera points, etc.) in accordance with the reflected ceiling drawings which are to be prepared by the Contractor and coordinated with all trades. These must be submitted for approval and be approved before any work commences on site.

4. Sufficient space shall be left clear to install all work to accommodate future materials and/or equipment as indicated and/or supplied by another trade. All pipe runs, conduit runs, cable trays etc. shall be installed to maintain maximum headroom and clearances, and to conserve space in shafts and ceiling spaces and under floors, and to provide adequate space for service and maintenance.

5. The exact location of outlets and fixtures shall be confirmed on the site, also the locations of outlets and fixtures provided by any other trade shall be confirmed.

1.1.22 Construction Drawings

1. The Contractor shall prepare drawings in conjunction with all trades concerned in the Works, showing sleeves and openings for all passages through the structure and all insert sizes and locations.

2. Composite construction drawings shall be prepared by the contractor for piping and equipment in tunnels, shafts, mechanical equipment rooms and areas, and all other critical locations to avoid a conflict of trades that are fully dimensioned. The equipment drawings shall be based upon shop drawings and include but not necessarily limited to, all details pertaining to access, clean outs, tapings, sleeves, electrical connections, drains, location and elevation of pipes, ducts, conduits, etc. obtained from consultation with, and agreement of, all trades involved.

3. The Contractor shall prepare drawings of equipment bases, pump pits, anchors, inertia slabs, floor and roof curbs, wall openings, trenches, pertaining to mechanical work.

4. All drawings shall be prepared to scale and dimension. These shall be forwarded, after approval by the trades concerned to the Engineer for his records. Transparencies and printed copies shall be provide in the number specified in the Project Documentation, but in any case not less than four sets.

5. The Contractor shall bind one complete set of construction drawings showing “as built” conditions in each operating and maintenance instruction manual. The extent of these drawings will be indicated to the Contractor in advance by the Engineer.
1.1.23 Shop Drawings and Other Information Required

1 The Contractor shall submit shop drawings and samples for materials and equipment as listed in this and in each subsequent section. Transparencies shall be provided wherever possible as well as printed copies in the number specified in the Project Documentation. The Engineer may retain the sample of each item at his discretion until the completion of the Works.

2 The Contractor shall submit to the Engineer a schedule of shop drawings after award of the Contract, in accordance with programme detailed in the Project Documentation. The schedule shall indicate the anticipated date when the drawings will be submitted for review. The Contractor shall be fully responsible for the timely submission of all drawings. An allowance of three weeks shall be made for the Engineer’s review period. At time of submission, the Contractor shall indicate any other constraints and associated cost implications resulting from the programme, etc. otherwise the Engineer will advise the Owner that cost and completion date will be unaffected.

3 The Engineer will only consider shop drawing bearing the stamp of the Contractor and all Subcontractors involved. The Contractor shall check the drawings for all pertinent information such as physical dimensions, make, performance, electrical characteristics, and shall use reference symbols or enumeration to correspond to the design drawings.

4 The Contractor shall assume responsibility for the accuracy of equipment dimensions related to space available, accessibility for maintenance and service and compliance with inspection authority codes. Shop Drawings shall indicate the shipping and working weights of all equipment.

5 The submission of samples will be subject to the same procedure as those of shop drawings. The materials for which samples are to be submitted shall include, but may not be limited to conduits and accessories, wiring accessories, distribution boards, cables and wires, fire alarm accessories, speakers, light fittings, sanitary fixtures and fittings, valves, Instruments, thermostats, Insulation and grilles and diffusers. One set of such samples shall be required to be brought to site and kept there after approval until substantial completion.

6 The Engineer shall mark the drawings “re-submit specified item”, “rejected”, “no exception taken”, or “make correction noted”. In the last case, all revisions will be clearly marked on the returned print and corrected prints may be issued for manufacture and construction. The Contractor shall make the revisions shown on the “make corrections as noted” prints onto the drawings as soon as practicable and forward copies to the Engineer for his records. This must be done within one month. Failure to re-submit in this time will cause the drawings to be treated as “revise and re-submit” and the contractor will be responsible for any delays so caused.

7 The Engineer is not responsible for any delays caused by the inadequacy of the Contractor’s drawings or his failure to obtain initial or subsequent approval. Any time taken by the Contractor to obtain approval after the originally scheduled date
will be considered as a delay to the contract caused by the Contractor.

8 When drawings are marked “re-submit specified item”, the Contractor is to re-submit the item as originally specified or as may be determined to be equivalent by the Engineer. The Engineer is the sole arbiter of whether any item is satisfactory or equivalent.

9 When drawings are marked “rejected” a complete re-submission of the particular drawing is necessary, subject to the same conditions as outlined above.

10 The Engineer’s review shall not relieve the Contractor from responsibility for deviations from the Project Documentation, unless he has, in writing, called the Engineer’s attention to such deviations at the time of submission of drawings. The Engineer’s review shall be construed to apply to, and only to, general arrangements and shall not relieve the Contractor from the entire responsibility. Any approval by the Engineer shall be on the understanding that any item submitted shall be ordered with options and modifications to fully meet the requirements of the Project Documentation. Any fabrication, erection, setting out or other work done in advance of receipt of stamped drawings shall be done entirely at the Contractor’s risk and cost.

11 The Contractor shall furnish prints of the reviewed details to all other parties who may require them for proper co-ordination of their work, and furnish all information necessary for the work as a whole.

12 The Contractor shall obtain manufacturer’s installation directions to aid in the proper execution of the work. Two copies of such directions shall be submitted to the Engineer prior to installation, for use in inspecting the work.

13 One complete set of checked shop drawings shall be bound into each operating and maintenance manual.

1.1.24 Record Drawings

1 As the job progresses, the Contractor shall mark on one set of prints to accurately indicate the status of installed work. The white prints shall be available for inspection at the site at all times, and be presented for scrutiny at all progress meetings. All information shall be transferred onto the set of transparencies. One set of transparencies and five sets of white prints shall be submitted to the Engineer for onward transmission to the Owner.

2 The record drawings shall show the installed inverts of all services entering and leaving the building and the property. Underground services shall be dimensioned at key points of every run in relation to the structure and building. Record all elevations for underground services shall be recorded in relation to floor level of the building and give reference datums to Municipality benchmarks.

3 The exact locations of all services left for future work shall be indicated. All embedded work shall be shown and dimensioned in the structure.
1.1.25 As-Built Drawings

1 Conspicuously indicate major deviation in Mechanical Equipment Rooms by specific reference to shop Drawings of these rooms and provide an accurate and complete record of the work as installed.

2 Upon completion of work, submit signed and certified lithe-tracing as-built and referenced shop Drawing, along with marked up prints of record Drawings to Engineer for acceptance.

1.1.26 Storage of Materials and Equipment

1 The Contractor shall protect all mechanical and electrical works from damage and shall keep all equipment dry and clean at all times.

2 All openings in equipment and materials shall be covered. All temporary openings in ducts and pipes with polyethylene sheets or caps shall be covered until the final connection is made. The quality of such cover must be determined with due regard to how long it may be until final connection.

3 The Contractor shall be responsible for and make good any damages caused directly or indirectly to any walls, floors, ceilings, woodwork, brickwork, finishes, services, roads, gardens etc.

4 Deliver and store HVAC equipment at the site, properly packed and crated until finally installed. Store materials in spaces approved by the Engineer. Investigate each space through which equipment must be moved. If necessary, have equipment shipped from manufacturer in crated sections of size suitable for moving through restricted spaces.

5 Adequately protect uninstalled equipment and materials against loss or stealing, damage caused by water, paging, fire plaster moisture, acids, fumes, duct or other environmental conditions, or physical damage, during delivery, storage, installation and shutdown conditions. Replace any damaged or stolen material without extra cost to the Employer.

6 Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do not work when conditions of temperature in area or moisture on materials or substrates are not in accordance with material manufacturer’s recommended conditions for installation.

7 Maintain all equipment and systems installed until, issuance of the certificate of practical completion. The operation of the equipment by the Employer does not constitute an acceptance of the work. Work shall be accepted only after the contractor has adjusted its equipment, demonstrated that it fulfills the requirements of the Drawings and Specifications, and has furnished all required documentation, and fulfilled all contract requirements.

8 Provide effective protection against damage for all materials and equipment during shipment and storage at the project site. Cover all stored equipment to
exclude dust and moisture. Place stored equipment on pallets or racks with appropriate weather cover.

9 After ductwork, piping and equipment are installed cover openings with temporary metal or plastic caps.

10 Protect all rough and finished floors and other finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulin, drip pans and oil-proof floor covering. Protect finished surfaces from welding and cutting splatters with baffles and splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

11 Deliver materials to project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

12 After completion of work, clean the exterior surfaces of equipment furnished in this division including concrete residue to the satisfaction of the Engineer.

1.1.27 Inspection of Material Prior to Installation

1 The following shall be inspected prior to Installation:

(a) pipe work and ductwork shall be checked for any obstructions or dirt
(b) dampers set shall be checked for damage and proper operation
(c) All material shall be inspected to ensure that it is an approved item.

1.1.28 Inspection, Testing and Adjusting

1 All the works provided as part of this Contract shall be inspected and commissioned in accordance with all relevant British Standards and to the entire satisfaction of the Engineer.

2 The electrical/mechanical subcontractor shall employ the services of a specialist testing and commissioning company approved by the Engineer. The specialist company should be regularly engaged in providing a testing and commissioning service and have been in continuous business for not less than seven (7) years. The company shall employ fully trained staff having not less than three (3) years dedicated experience. A senior experienced commissioning engineer with minimum dedicated experience of seven (7) years shall be responsible for supervising and directing the activities for the testing and commissioning team.

3 The Contractor shall carry out all tests specified any other tests required by the Engineer. Equipment shall be tested to the requirements of, and where necessary, in the presence of the manufacturer and the Engineer.

4 The Contractor shall provide all equipment, labour, instruments, loading devices, incidentals, and pay for all fuel, power and sundries required to carry out the tests.
All installations shall be inspected and tested in sections as the work proceeds and on completion as composite systems and it shall be noted that the Engineer or any of the other relevant Authorities may require to inspect or test any equipment during manufacture at the manufacturer’s works. All necessary arrangements shall be made as part of this Contract. This will generally not apply to specified items unless specifically noted in the Project Documentation, but may be necessary for alternate equipment, should this be considered at all.

All tests shall be arranged in co-operation with the Engineer and all other concerned parties and shall be subject to at least five (5) days notice in writing of the time, location and nature of the test to be performed. Not test shall be considered valid unless the Engineer is present.

All necessary skilled and unskilled labour shall be provided for attendance during the tests (including pre-and post-test activities) and the test media shall be provided and subsequently disposed of except where specifically stated otherwise.

The testing and adjusting is the contractual responsibility of the Contractor but actual performance of the tests is expected to the sole responsibility of an approved subcontractor.

The Contractor shall have all testing and balancing performed only by persons who are thoroughly versed in this type of testing and balancing and with proven ability. Names, complete with experience records, and references shall be submitted for the approval of the Engineer.

Any defects occurring at any time during the test duration shall be made good and a complete re-test shall be carried out, at no additional cost to the Contract.

Where failure occurs during a test, inspection or commissioning procedure which results in damage to the building fabric and/or any services not provides as part of this Contract, or requires subsequent builder’s work to be carried out, this work shall be performed to the entire satisfaction of the Engineer at no additional cost to the Contract.

All the test points shall be provided which are necessary to carry out the specified tests and commissioning procedures including facilities for measuring or monitoring temperature, pressure, pressure drop, volume flow, in-duct sound power or sound pressure, humidity, or other relevant conditions in both air side and water side systems. Such points shall be fitted with removable plugs, flanges, or other appropriate and approved devices.

Prepare test report forms for each test to be performed and submit these to the Engineer at least two weeks prior to the commencement of any tests.

Only after the system installation has been completed and the system has been put into continuous operation shall testing be carried out. The testing, adjusting, and balancing shall be performed when outside conditions are commensurate with the design conditions for the given system. Dummy loads shall be added to
the system if outside conditions are less severe than the specified points.

15 The Contractor shall prepare a complete list of instruments for each test containing for each instrument.

(a) name of instrument manufacturer
(b) scale and full scale accuracy
(c) date of last calibration test
(d) name of last calibrating company.

16 All instruments and consumable, such as recording paper, necessary for conducting the tests shall be provided, including but not limited to the following:-

(a) electronic anemometer
(b) inclined tube manometer or micromanometer
(c) pitot tubes of various lengths
(d) digital thermometers
(e) weekly recording thermometers
(f) weekly recording relative humidity meter
(g) anemometer for diffusers, with collector
(h) ammeter, voltmeter, wattmeter
(i) power factor meter
(j) insulation tester
(k) earth loop impedance tester
(l) tachometer

17 Duplicate signed test certificates shall be provided after each test which will be countersigned by the attending Engineer. The test certificate shall give the following particulars:

(a) apparatus or section under test
(b) maker’s number (if any)
(c) nature, duration and conditions of test
(d) result of test

No test shall be valid until the test certificate is provided.

18 Duplicate copies of test certificates carried out at manufacturer’s works shall be forwarded to the Engineer for approval prior to despatch of the article to site.
19 No section of the Works shall be insulated or in any other way concealed prior to testing and inspection and subsequent concealment where applicable shall only take place following written authority from the Engineer.

1.1.29 Testing

1 All necessary facilities, measuring and recording instruments including test pumps and gauges for inspection, testing and commissioning requirements shall be provided and shall be checked or calibrated as necessary before use.

2 The Engineer reserves the right to call for a demonstration of the accuracy of any instruments provided.

3 All representatives present during inspection, testing and commissioning shall be fully conversant with the system concerned and the method of system and instrument operation.

4 Manufacturer's of specialist subcontractors' representatives shall attend where specifically indicated elsewhere in the Project Documentation or where necessary to ensure full service and co-operation is available to the Engineer to enable the Works to be tested and commissioned in accordance with the requirements of the Project Documentation.

5 All necessary precautions shall be taken to safeguard structures and existing equipment against damage during inspection, testing or commissioning. Any damage so caused shall be made good at no cost to the Contract.

6 All tests shall last for the minimum time period stated or longer if necessary to ensure all sections have been fully examined as required by the test.

1.1.30 Instructions for Operation and Routine Maintenance

1 The Contractor shall provide instruction to the Owner’s staff on how to make minor adjustments, carry out necessary maintenance and how to operate each system.

2 For new equipment, the Contractor shall provide the Engineer with three copies of complete operating and maintenance instruction for equipment at the time of delivery of the equipment.

3 Equipment shall be rejected unless accompanies by instructions. Such documents must be received at least one month prior to the completion date of the relative section of the Works.

4 Instructions shall be bound in a suitable loose leaf booklet or binder, and shall include prints of the following:

(a) list of all equipment installed
(b) general layout
(c) wiring diagram of control panels
(d) non-dimensional layout, showing location of all electrical devices
(e) Introduction-explanation of manual and its use.
(f) Description of system and/or equipment with complete schematic drawing of all systems and functional and sequential description of all systems.
(g) System operation with operation procedures and all posted instruction charts.
(h) Maintenance with systems trouble-shooting charts, procedures for checking out functions and recommended list of spare parts and cost schedule or recommended maintenance.
(i) Listing of manufacturers.
(j) Manufacturer's data: Where multiple model, type and size listing are included, clearly and conspicuously indicate those that are pertinent to this installation with description literature, drawings, illustrations, certified performance charts, technical data, etc., operation maintenance including complete trouble-shooting charts, parts list, names addresses and telephone numbers of recommended repair and service companies and guarantee data.

5 The contractor is to operate a draft for discussion with the Engineer prior to finalising the documents.

6 Portable tools and spare parts shall be correctly labelled and handed over to the Engineer.

7 The section dealing with complete systems shall be subdivided into each service with a ready means of reference and detailed index. The function and manner of operation of each system shall be clearly described together with illustrations and line diagrams in schematic form showing the location and function of control valves, items of equipment and spaces or areas which are service by these items. The colour coding and identification systems employed shall be explained.

8 After completion of all required equipment and system tests and unless specifically noted elsewhere in these specifications, provide at Employer's/Operator's convenience knowledgeable personnel and necessary equipment to reasonably instruct and demonstrate the operation and maintenance of said equipment and system. Where specifically indicated, arrange for the related manufacturer or authorized representative to assist with this orientation. The orientation shall be a minimum of ten (10) days in addition to start up time.

9 Before requesting acceptance of work, furnish coordinate with other contract documents in bound of a complete instruction manual type written or printed.
1.1.31 Maintenance

1 During the maintenance period, the operation and day to day routine maintenance of the plant and equipment shall be carried out by the owner's staff whereas the defects / failure in the plant and equipment not as a result of inadequate.

2 Maintenance, shall be part of the Contractor's responsibility and shall be rectified free of cost by the Contractor.

3 During the last month of the Maintenance period, the Contractor shall demonstrate to the Engineer that all equipment and systems are operating according to the capacities and the manner set down in the specifications. On completion of these tests, the Engineer shall issue a formal letter of acceptance for the equipment and system or parts of the system satisfactorily tested and approved.

4 The Maintenance Certificate will not be issued to the Contractor by the Engineer until all plant has received the above mentioned letter of acceptance and/or unless a bank guarantee is provided by the Contractor for the performance of that part of the plant and equipment not formally tested and accepted.

1.1.32 Warranty

1 All Warrantees for equipment suppliers will be vested in the Owner regardless of whether the Contractor who supplied the equipment is still associated with the Project or not.

2 Warranty will be full warranty and will include all overhead, profit, incidental charges and sundries.

3 Where damage is caused to any other item by any failure of the item warranted then the warranty shall also include the costs incurred in rectifying the damage.
2. CENTRAL REFRIGERATION & AIR CONDITIONING EQUIPMENT

2.1 GENERAL

2.1.1 Related Documents

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

2.1.2 Scope

1 This Part specifies the requirements of the design manufacture, construction installation testing and commissioning of central refrigeration and air conditioning equipment.

2.1.3 References

1 The following standards and organisations are referred to in this Part:

(a) NEMA Standard pub/No’s MG 1, 2,3,10 & 11 for energy efficient motors.

(b) ASHRAE

2.1.4 Submittals

1 The following shall be submitted for approval:

(a) Equipment data including certified performance curves, finished specialties and accessories.

(b) Shop drawings showing layout connections and construction materials for each equipment including setting drawings for installation.

(c) Wiring diagrams detailing wiring for power, signal and control systems between manufacturers installed wiring and field installed wiring.

(d) Installation and start up instructions and Operation and Maintenance data Manual.

(e) Equipment shall be factory tested; certified shop performance test and certified shop static and dynamic test shall be submitted for review before deliver to site.
2.1.5 Products

1. Materials and equipment furnished under these specifications shall be standard catalogue products of manufacturers regularly engaged in production of such materials or equipment and shall be the manufacturer’s latest standard design complying with the specification requirements and meets and capacity indicated in the Project Documentation. Where two or more units of the same class of equipment are required, these units shall be produced of a single manufacturer. However, the component parts of the system need not be the products of the same manufacturer.

2. Each major component of equipment shall have the manufacturer’s name address, and catalogue number on a nameplate securely affixed in a conspicuous place; the nameplate of a distributing agent only will not be acceptable.

2.2 AIR COOLED PACKAGED AIR CONDITIONING UNITS

2.2.1 General

1. Roof top Package Unit shall be factory assembled, internal mixing, pre-charged, pre-wired, manufactured in an ISO registered 9002 facility and tested for capacity ratings according to ARI standard 340 & 360. Each unit shall consist of compressors, condenser, evaporator, expansion valve, filter drier, Isolation valves for filter drier and charging ports, sight glass, phase sequence, voltage protection, solenoid valve, service valve, interconnecting refrigerant piping and all other standard accessories and controls.

2. The only required field connections shall be the system ductwork, electrical power supply and external control cables when required.

3. The units shall be provided with lifting lugs for easy site handling.

4. The Packaged Air Conditioning Units controls and starters shall be housed in a weather proof and dust proof enclosure with lockable door. The minimum rating for the enclosure shall be IP65.

5. Adequate space shall be provided for operating and maintenance purpose.

6. The system shall be designed and supplied with the refrigerant as specified in the Project Documentation.

7. The power supply cables and protective devices shall be rated as recommended by the manufacturer.

8. The Packaged Air Conditioning Units shall be selected to meet the capacities as detailed in the Project Documentation.

9. The Packaged Air Conditioning Units shall be selected to meet the components as detailed in the project drawings and documentation.
10 The compressor type shall be as specified in the Project Documentation.

11 The Packaged Air Conditioning Units shall be capable of operating in ambient conditions of 55°C.

12 The Packaged Air Conditioning Units shall be in accordance with the latest QGEWC regulations.

13 The manufacturer’s details should be followed wherever possible.

14 Adequate space shall be provided for operating and maintenance purpose.

15 The necessary corrosion allowance and weather proof resistance materials shall be considered for all roof top packaged units. Consideration shall also be towards hot, humid, native desert and severe corrosive coastal environment with frequent sandstorms, necessary precautions shall be implemented by the air cooled RTUs manufacturer.

2.2.2 Product

1 General: The modular packaged unit is a factory assembled suitable for mounting on the roof. The packaged unit consists of scroll or screw compressors and as per project requirements, cooling coil, condenser coil, fans, electric heater, control wiring and interconnecting piping – all factory assembled. Unit casing is of rigid construction mounted on pressed steel rail base with lifting holes for overhead rigging. The unit is provided with an integral weather resistant control panel, ready for field connection.

2 Roof Top Package Unit shall be rated to ARI Standard 360/340 or equivalent and guaranteed to operate at published capacities.

3 Unit Enclosure: Unit casing shall be weather-proof construction, made of heavy gauge galvanized steel, backed enamel finish. The unit must be fitted with 1” thermal and acoustic insulation to the whole assembly. All panels shall be easily removable and all components must be easily accessible for servicing. Evaporator section shall have suitably insulated stainless eel drain pan and drain connections.

4 Compressor: Shall be of scroll type complete with vibration isolators, crankcase heaters, internal protection, low pressure / High Pressure cutouts, oil level sight glass, etc. Units shall be supplied with multi-compressor (minimum 2 circuits), each compressor shall have its independent refrigerant circuit (exception for units below 10 T.R.), and Compressors shall be tested and rated in accordance with ISO Standard 917 or equivalent and guaranteed to operate at published capacities.

5 Insulation: Evaporator section is insulated with 1 inch (25 mm) thick 3 pounds per cubic foot (48 kg/m3) density polystyrene insulation, which will prevent condensation from forming on the casing. Insulation meets the requirements of NFPA 90A and is protected against deterioration and erosion from air currents.
6 Evaporator and Condenser Coils: coil shall be constructed of seamless copper tubes with aluminium pre coated fins mechanically bonded to the tube. The condenser fans shall be direct driven propeller type. Condenser discharge shall be protected with bird screen.

7 The air-cooled condenser shall be a complete factory-fabricated and factory assembled unit consisting of the following:

(a) Fans:
   (i) Propeller type or centrifugal type directly connected to the motor shaft or indirectly connected to the motor by means of a V-belt drive.
   (ii) Fans shall be statically and dynamically balanced.
   (iii) Fans should be provided with overload protection.

(b) The Housing shall consist of:
   (i) The frame and supports shall be constructed of galvanized angle iron
   (ii) The casing shall be constructed of hot dip galvanized steel
   (iii) Vibration isolators

(c) Motors:
   (i) Totally enclosed, fan-cooled for all installations where motor is exposed to the weather or in an air stream.
   (ii) Open drip-proof type class F insulation within an enclosure to be fully protected from the weather and shall be IP 55.
   (iii) Motor starter shall be a magnetic across the line type within a watertight enclosure.
   (iv) Thermal protection shall be of the manual or automatic reset type.
   (v) Motors shall be complete with internal thermal overload protection in addition external overload protection.

8 Condenser Controls. One of the following methods of controlling condensing temperature shall be provided:

(a) Air volume control: A condenser with multiple fans may be provided with a fan cycling control to cycle one of two, or two of three fans act in response to outdoor ambient temperatures.

9 Evaporator coil shall be of the same construction of condenser coil and fan. Fans shall be of the double width – double inlet type with direct driven or belt driven motors and shall be installed on adjustable base and secured by a locking device. Belt driven fans shall be provided with adjustable pitch pulley. The entire fan assembly shall be statically and dynamically balanced.

10 Filter section shall be of integral part of the unit and filter cell shall be cleanable metallic type, 2" thickness. Filter face velocity shall not exceed 400 fpm.
11 Package unit shall be complete with pre and final filters as mentioned in equipment schedule.

12 Pre filter can be affixed in filter section to return air ductwork.

13 The unit shall be complete with the following minimum control and protection devices:

(a) Safety interlocking between evaporator fan motor with compressor operation and mechanical interlocking through an airflow switch.

(b) Sequence operation for compressors in accordance with return air temperature.

(c) Manually reset and adjustable high pressure and adjustable low-pressure cutout for compressor protection.

(d) Manually reset and adjustable oil pressure differential cutout of 90/120 sec.

(e) Time guard circuit for preventing compressor rapid recycling of adjustable range from 5 minutes to 15 minutes.

(f) Time delay relay for sequence starting of multiple compressors system of minimum 15 sec.

(g) Separate single phasing preventor with a response time rating of maximum 2 sec.

(h) Inherent thermal protection and overload with manual reset for compressor motor winding and fans motor winding.

(i) Earthling point.

(j) Thermostat housed in a suitable perforated casing with lock.

(k) Fans motor shall be IP 55 with class B insulation and with internal thermal overload protection in addition external overload protection.

14 Refrigerant: Refrigerant must be 410a or 407C.

15 Accessories:

(a) Combination filters with a dryer in the refrigerant line, so arranged that cartridges can be replaced when the refrigerant circuit is changed.

(b) Combination sight-glass and moisture indicator.

(c) Solenoid valve in the refrigerant line.

(d) Expansion valve on refrigerant line at coil inlet with the bulb located immediately after the coil outlet.

(e) Refrigerant charging connection in the liquid line.

(f) The unit shall be complete with the following:

(i) Washable metallic pre filter having filtration efficiency not less than 80 percent and be 50 mm thick, the filters should conform to ASHRAE
62-92 standards. Filters shall be accessible through a removable access door sealed airtight.

(ii) Air supply and air return isolation dampers.

(iii) Channel base frame.

(iv) Differential pressure switch and Manometers across each and every filter and signal to the control panel.

(v) Full set unit controls with hour run meter for each compressor.

16 Microprocessor Control Panel

(a) Each package A/C unit shall be equipped with Microprocessor based control panel to enable monitoring and diagnostics of various functions. The control panel shall incorporate all provisions to be integrated with the Building Management System as specified in drawings and specifications.

17 Energy Efficiency Ratio (EER)

(a) The package A/C units shall have minimum EER in accordance with local KAHRAMAA regulations and shall comply with ASHRAE 90.1 - 2010. The test standard shall be AR I 340/360 or AR I 390 as applicable.

18 Unit’s Control

(a) The unit’s electrical control should include compressor contactor, condenser and evaporator fan contactors and control transformer. Safety controls shall include combination compressor winding thermostat, current overload device and phase failure protection. The unit power wiring shall enter at a single point through cable gland.

19 Unit Protection Devices and Operation Sequences

(a) The unit shall be equipped with a room/duct mounted thermostat; The operation switch shall be with a function of “OFF-FAN-COOL’. The operation control shall conform to manual starting, automatic continuous operation whenever the thermostat requires and the protection devices allow. The unit shall be restarted by resetting the operation switch if any one of the protection devices trips.

(b) A switch on the remote control box manually selects the ventilating or cooling operation. When the operating switch is set at “FAN”, the evaporator fan is started. When the operation switch is set at “COOL” and all electrical protective devices are satisfied, the thermostat controls the compressor operation.

2.2.3 Executions

1 Installation

(a) All units must be earthed.
(b) Units shall be installed in accordance with manufacturer installation instructions and Drawings.
(c) Provide shop drawings indicating the location of the oil separator before installation.
(d) Provide clearances for servicing and maintenance.

2.3 AIR COOLED CONDENSING UNITS

2.3.1 Product

1 Air-cooled condenser shall be rated to ARI Standard 210 or equivalent and guaranteed to operate at published capacities.

2 Air-cooled condenser shall be suitable for remote installation in a weather protected casing, or for use with self-contained air conditioners.

3 The Air Cooled Condensing Units shall be capable of operating in ambient conditions of 55°C.

4 Unit Enclosure: Unit casing shall be weather-proof construction, made of heavy gauge galvanized steel, backed enamel finish. The unit must be fitted with 1" thermal and acoustic insulation to the whole assembly. All panels shall be easily removable and all components must be easily accessible for servicing. Evaporator section shall have suitably insulated drain pan and drain connections.

5 Compressor: Shall be of scroll type complete with vibration isolators, crankcase heaters, internal protection, low pressure / High Pressure cut-outs, oil level sight glass, etc. Units shall be supplied with multi-compressor (minimum 2 circuits), each compressor shall have its independent refrigerant circuit(exception for units below 10 T.R ), and Compressors shall be tested and rated in accordance with ISO Standard 917 or equivalent and guaranteed to operate at published capacities

6 Coils: coil shall be constructed of seamless copper tubes with aluminium pre coated fins mechanically bonded to the tube. The condenser fans shall be direct driven propeller type. Condenser discharge shall be protected with bird screen.

7 The air-cooled condenser shall be a complete factory-fabricated and factory assembled unit consisting of the following:

(a) Fans:
   (i) Propeller type or centrifugal type directly connected to the motor shaft or indirectly connected to the motor by means of a V-belt drive.
   (ii) Fans shall be statically and dynamically balanced.
   (iii) Fans should be provided with overload protection.

(b) The Housing shall consist of:
   (i) The frame and supports shall be constructed of galvanized angle iron
(ii) The casing shall be constructed of hot dip galvanized steel.

(iii) Vibration isolators

(c) Motors:

(i) Totally enclosed, fan-cooled for all installations where motor is exposed to the weather or in an air stream.

(ii) Open drip-proof type class F insulation within an enclosure to be fully protected from the weather and shall be IP 55.

(iii) Motor starter shall be a magnetic across the line type within a watertight enclosure.

(iv) Thermal protection shall be of the manual or automatic reset type.

(v) Motors shall be complete with internal thermal overload protection in addition external overload protection.

8 Condenser Controls. One of the following methods of controlling condensing temperature shall be provided:

9 Air volume control: A condenser with multiple fans may be provided with a fan cycling control to cycle one of two, or two of three fans act in response to outdoor ambient temperatures.

10 Refrigerant: Refrigerant must be 410a or 407C.

11 Accessories:

(a) Combination filters with a dryer in the refrigerant line, so arranged that cartridges can be replaced when the refrigerant circuit is changed.

(b) Combination sight-glass and moisture indicator.

(c) Solenoid valve in the refrigerant line.

(d) Expansion valve on refrigerant line at coil inlet with the bulb located immediately after the coil outlet.

(e) Refrigerant charging connection in the liquid line.

(f) The unit shall be complete with the following:

(i) Washable metallic pre filter having filtration efficiency not less than 80 percent and be 50 mm thick, the filters should conform to ASHRAE 62-92 standards. Filters shall be accessible through a removable access door sealed airtight.

(ii) Air supply and air return isolation dampers.

(iii) Channel base frame.

(iv) Differential pressure switch and Manometers across each and every filter and signal to the control panel.

(v) Full set unit controls with hour run meter for each compressor.
12 Microprocessor Control Panel

(a) Each condensing units shall be equipped with Microprocessor based control panel to enable monitoring and diagnostics of various functions. The control panel shall incorporate all provisions to be integrated with the Building Management System as specified in drawings and specifications.

13 Energy Efficiency Ratio (EER)

(a) The condensing units shall have minimum EER in accordance with local KAHRAMAA regulations and shall comply with ASHRAE 90.1 - 2010. The test standard shall be AR I 340/360 or AR I 390 as applicable.

14 Unit’s Control

(a) The unit’s electrical control should include compressor contactor, condenser and evaporator fan contactors and control transformer. Safety controls shall include combination compressor winding thermostat, current overload device and phase failure protection. The unit power wiring shall enter at a single point through cable gland.

15 Unit Protection Devices and Operation Sequences

2.3.2 Execution

1 Installation

(a) The contractor shall level each machine in accordance with manufacturer’s recommendations and submit levelling data to the engineer for review.

(b) Units shall be installed in accordance with manufacturer’s installation instructions.

(c) Install unit plumb and level, firmly anchored and maintain manufacturer’s recommended clearances for servicing and maintenance.

(d) Install vibration isolators with anchor bolts and secure unit to vibration isolators.

(e) Inspection and performance tests shall be carried out on contractor expenses to the satisfaction of the engineer.

2.4 VARIABLE REFRIGERANT AIR-CONDITIONING-HEAT PUMP UNITS (VRV)

2.4.1 General

1 Variable refrigerant air-conditioning-heat pump systems shall be installed to provide heating or cooling to the areas via individually controlled room units on the same refrigeration circuit.

2 Variable refrigerant air-conditioning-heat pump, condensing units shall be an air
cooled modular Designed for variable refrigerant system.

3 Variable refrigerant air-conditioning-heat pump shall be an Inverter Driven 2 Pipe Heat Pump system, which operates on energy efficient R410A refrigerant.

4 Refrigerant shall be R410A.

5 Variable refrigerant air-conditioning-heat pump system shall be based on one modular outdoor air cooled condensing unit connected via a single refrigerant circuit comprising suction and liquid pipe work for indoor units and/or air handling units, of different types and capacities. The total load of the indoor units and/or air handling units should not exceed the total outdoor unit’s capability.

6 Variable refrigerant air-conditioning-heat pump system shall be capable of operating when ambient temperatures vary between (55°C and 10°C) in cooling mode.

7 Refrigerant pipe work circuit shall be designed to satisfy the distance between the outdoor condensing unit and the farthest indoor unit and/or air handling unit on the circuit and may incorporate the level difference without the necessity for any oil traps.

8 Operation of the variable refrigerant air-conditioning-heat pump system shall permit either cooling or heating of each indoor unit or all of the indoor units serving a common room. Each indoor unit or group of indoor units shall be able to set temperature independently via a local remote controller, an Intelligent Controller, an Intelligent Manager and/or a BMS interface.

9 Variable refrigerant air-conditioning-heat pump system shall operate with Refrigerant R410A, the installation to be in accordance with BS EN378: 2000 Parts 1-4 and manufacturer’s design and installation instruction.


11 The VRF manufacturer or his approved local representative in Qatar should review the outdoor and indoor selection, design and review the insulated piping network, install, connect, test, balance and commission the VRF system or supervise the above complete with its associated piping and insulation work.

2.4.2 INDOOR CONCEALED UNITS COMPONENTS

1 General: Galvanized steel cabinet.

(a) Insulation: Fully lined with 15 mm thick, glass-fiber acoustic and thermal insulation, insulation shall conform to BS476 Part 7 fire rating.
(b) Retain option in subparagraph below to comply with LEED-NC Prerequisite EQ 1.

(c) Drain Pans: Galvanized steel, extended type, and auxiliary drain pan of 1.2 mm thick, with connection for drain; lined with closed cell, fire retardant, foam insulation and complying with ASHRAE 62.1.

(d) Retain subparagraph below to comply with LEED-NC Prerequisite EQ 1.

(e) Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2 Indoor unit types and capacities as shown in the design documents.

3 Indoor units can be configured to guarantee capacities up till 130 % of the listed capacity of the connected outdoor unit (Condensing unit).

4 Unrestricted positioning of the indoor units shall be at least 190m pipe run allowance with a height difference of 90 m from the outdoor unit and up to 30m among the indoor units.

5 Units shall be provided with low noise direct drive fan, motor, heat exchanger, electronic expansion valve, drain pump built in, insulated drain pan and refrigerant filters.

6 Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and coil number of rows not less than 3 rows deep.

7 Retain one of first two paragraphs below if heating is required.

8 Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor, dynamically and statically balanced.

(a) Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add paragraphs below to suit Project.

(b) Motors shall be DC motor, permanent split capacitor type with UL listed thermal overload protection.

(c) Arrange the motor blower assembly for easy removal, including a quick disconnect on the motor cord. Include sleeve type or ball bearing type motor bearings.

9 Retain option in first paragraph below if applying for LEED certification. LEED-NC Prerequisite EQ 1 requires compliance with ASHRAE 62.1-2004, which requires a MERV rating of 6 or higher.

10 Washable Filters: 25 mm thick, in fiberboard frames with ASHRAE 52.2 MERV rating of 6 or higher.

11 Wiring Terminations:
(a) All electric wiring between the fan motor, unit mounted controls and junction box mounted on the unit will be and factory installed by the manufacturer. Provide suitable terminals for field connections of power and thermostat and valve control wiring.

(b) Indoor unit printed circuit board shall be complete with power input fusing, address switches for a variety of operation controls, emergency operation switch and fault/operation indication LED's. Fan motors shall be thermally protected.

12 Controls:

(a) Furnish the controls as specified and to be installed by contractor and wired by the Electrical Contractor.

(b) Basic components of the indoor units are a fan, a heat exchanger and an electronic proportional expansion valve which shall be controlled via computerized PID control which constantly, every 20 seconds measures and assesses the status of the return air temperature, refrigerant inlet and outlet temperature.

(c) During the cooling operation the electronic expansion valve shall control the degree of refrigerant superheat at the evaporator outlet. During the heating operation it shall control the degree of refrigerant sub cooling at the condenser outlet.

13 Thermostat: Thermostat, with warmer/cooler knob, calibrated with degree readings and 3-speed/ off fan control switch. Include 1°C dead band.

14 Provide mounting brackets for ceiling suspension, including approved vibration elimination devices and discharge duct collar.

15 Indoor unit (Cassette type) shall be completed with fresh air intake collar.

2.4.3 Indoor Floor-Mounting Units Components

1 Same as INDOOR CONCEALED UNITS COMPONENTS specified herein except the followings:

(a) Cabinet: Enamel steel or high quality plastic with removable panels on front and ends in color selected by Engineer.

(b) Fan: Direct drive, centrifugal, with power-induced outside air.

(c) Filters: Permanent, cleanable.

2.4.4 Indoor Wall-Mounting, Units Components

1 Same as INDOOR CONCEALED UNITS COMPONENTS specified herein except the followings:

(a) Retain subparagraphs below to comply with LEED-NC Prerequisite EQ 1.

(b) Cabinet: Enamel steel or high quality plastic with removable panels on
front and ends in color selected by Engineer, and discharge drain pans with drain connection.

(c) Fan: Direct drive, centrifugal fan.
(d) Filters: Permanent, cleanable.

2.4.5 Indoor Ceiling And Cassette-Mounting, Units Components

1 Same as INDOOR CONCEALED UNITS COMPONENTS specified herein except the followings:

(a) Cabinet: Enameled steel or high quality plastic with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

(b) Fan: Direct drive, centrifugal fan, with power-induced outside air, and integral condensate pump.

(c) Filters: Permanent, cleanable.

2.4.6 Air-Cooled, Condenser Components

1 Casing: Steel, finished with baked enamel in color selected by Engineer or as per manufacturer standard, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2 Outdoor condensing units shall be completely weather proofed to corrosion resistant type E1. Factory assembled in a sturdy weatherproofed casing constructed from rust-proofed mild steel panels (Galbarian Steel) coated with an electro-painted oven baked enamel finish. Also pre-charged, pre-wired and completed with all necessary electronic and refrigerant controls for ease of installation and factory tested. The necessary corrosion allowance and weather proof resistance materials shall be considered for all VRF air cooled condensing units. Consideration shall also be towards hot, humid, native desert and severe corrosive coastal environment with frequent sandstorms, necessary precautions shall be implemented by the VRF unit manufacturer.

3 Compressor: Hermetically sealed Inverter Scroll, mounted on vibration isolation.

(a) Compressor Type: Inverter Scroll with oil filter.

(b) DC compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

(c) Refrigerant: R-410A.

(d) Liquid receiver.

(e) Oil equalizer system between compressors and condensers.

(f) The motor is cooled by pressurized gas and has no accumulator.

4 Each outdoor unit shall have inverter driven compressor electronically controlled
and capable of changing the speed linearly to follow the variations in cooling or heating load. In the cases of two or more compressors there shall be duty balancing. This shall be by the use of HIDECS circuit (Hi Inverter Drive and Electronics Control System) together with independent multi-variable PI (Proportional Integral) control for the precise monitoring of status of the system. With optimum capacity control of all compressors in accordance with load.

5 The outdoor units having capacity (22.4kW) and above shall have a minimum of two compressors and able to operate even in case that one compressor is out of order.

6 Refrigerant Coil: Copper tube, with mechanically bonded aluminum PE treated fins, complying with ARI 210/240, and with liquid sub-cooler.

7 The refrigeration circuit of the outdoor unit shall include a SCe-Bridge Circuit complete with solenoid valves, 4 way valve(s), distribution headers, capillaries, filters, shut off valves, service ports and receivers.

8 The oil recovery cycle shall be automatic, occurring 1 hour after start of operation and then every 8 hours of operation. Oil separators are standard with the equipment together with oil equalization system between compressors and condensers.

9 Retain first paragraph below for heat pump units.

10 Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

11 Condenser Fan:

(a) Aluminum-propeller type with DC multi-speed motor directly connected to motor.

(b) Outdoor fan impeller shall be of aero spiral type, designed for low noise operation with manipulation on the fan blade edges to reduce turbulence and have an aero fitting discharge grill. The fan motor shall be DC (Digital Commutator brushless motor) inverter speed control to maintain constant head pressure control in all ambient conditions and modes of operation. Fan motors shall have external static pressure of minimum 78Pa.

(c) Night set back control of the fan motor for low noise operation by way of limiting the maximum speed will be permitted.

12 Low Ambient temperature Kit.

13 Unit shall be designed to work with several indoor units connected to the same refrigerant circuit.

14 Unit shall be designed to work with air handling units, the air handling unit shall having multi refrigerant circuits with a maximum capacity (28 Kw) of each circuit.
15 Automatic control system shall handle the conditions of the operation of any number of indoor units down to one, the frequency of the inverter control to be determined electronically be sensing ambient temperature, operational pressures and monitoring the exact requirements of all the connected indoor units.

16 The units to be equipped with the back-up function, which allow the other outdoor units to operate as emergency to prevent the total shutdown of the system, even when one of the outdoor unit goes out of order.

17 Capacity control of the outdoor unit shall be inverter controlled with 13 steps for the outdoor units having capacity (22.4KW) and min of 20 steps for all other models, then with by-pass for minimum capacity control of 8% on the other models. The frequency of inverter control shall be determined electronically by sensing ambient temperatures, operational pressures and monitoring the exact requirement of all of the connected indoor units.

18 Retain paragraph below if applying for LEED certification. LEED-NC Prerequisite EA 2 requires minimum efficiency equal to requirements in ASHRAE/IESNA 90.1-2004.


20 Heat Exchanger

(a) The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The fins are to be covered with an anti-corrosion Acrylic resin and hydrophilic film type E1. The pipe plates shall be treated with powdered polyester resin for corrosion prevention.

2.4.7 Accessories

1 The outdoor electronic PCB’s shall be lead free and have selection switches for the length of pipe work, ambient range selection, emergency operation switches, and service mode switches, together with LED indications for the number of fan coils connected, the frequency status and operational/fault indication. The control circuit shall have a pump down facility to enable collection of the entire refrigerant charge in the system at the outdoor unit.

2 The units shall have microprocessor control system incorporated to enable oil return, stability of refrigerant flow and capacity balancing.

3 The following safety devices shall be part of the outdoor unit:

(a) High and low pressure switches.
(b) Control circuit fuses.
(c) Crank case heaters.
(d) Thermal protectors for compressor and fan motors.
(e) Over current protection for inverter.
(f) Anti-recycling timers.

4 The condensing units shall be capable of sequential start when more than one unit is installed and have an auto restart capability after power failure as standard.

2.4.8 Controls

1 The controls system shall include all necessary remote controllers and interface PCB’s.

2 Remote controller shall be provided per room/Zone or fan coil as specified and be capable of controlling an individual fan coil or group of fan coils, up to 8 indoor units. Also unified ON/OFF controllers each to control up to 16 groups indoor units(max.64 indoor unit) and Central controller to control up to 64 units X4 system = 256 indoor units.

3 The controller shall have a liquid crystal display and provide the following facilities:

(a) Temperature setting.
(b) Fan speed setting.
(c) Mode setting fan/cooling.
(d) On/Off control.
(e) Diagnostics Feedback.
(f) 7 Day Timer Function.

4 Remote air sensors shall be provided for local room sensing where fresh air is introduced to the indoor unit. To be positioned within the room or close to the return air grill in the ceiling.

5 Air Conditioning Central Management System

6 All the air conditioning systems shall be controlled by an intelligent Touch Controller system with full colour LCD touch panel and Icon display as manufactured, with Power Proportional Distribution Function (PPD) for individual billing. With the following functions:

(a) Automatic cooling/heating changeover.
(b) Heating optimization.
(c) Temperature limit.
(d) Power Proportional Distribution.
(e) Fire emergency stop control.
(f) Flexible timer functionality.
(g) Flexible grouping in zones.
(h) Historical data.
(i) Schedule timer and holiday setting.
(j) Password security levels.
(k) Operation of up to 64 units of indoor X 4 system (with maximum 256 indoor units).
(l) ON/OFF, operation mode setting, temperature setting, fan speed setting, to be controlled from BMS and override the remote controller local operation.

7 Control Module: Remote mounted adjustable thermostat with heat anticipator, off-heat-auto-cool switch, high-low fan switch.

8 The system use the PID control technology to provide temperature + 0.5 C from the room set point.

9 The units shall be equipped with the auto restart function.

10 Communication adaptor:
   (a) Interface unit to be supplied to allow communications between variable refrigerant air-conditioning-heat pump units and BMS’s. BMS ready to run and monitor the air conditioning systems.

11 BMS Interface:
   (a) Each VRV outdoors unit shall be equipped with Microprocessor based control panel to enable monitoring and diagnostics of various functions. The control panel shall incorporate all provisions to be integrated with the Building Management System as specified in drawings and specifications.

12 Auto Check Function:
   (a) The system shall employs the Auto check function for connection errors of the unit wiring and piping, to be shown on the PC board in the outdoor unit and BMS system.

**2.4.9 Refrigerant Piping (VRV System)**

1 Y style piping joints and headers provided by the manufacturer shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints and/or joints provided by the installing contractor shall not be acceptable.

2 REFNET™ joints must be as per VRV supplier recommendation.

3 Refrigerant piping network design / sizing must be VRV supplier responsibility.
and subject to Engineer approval.

2.4.10 Execution

1 Installation

(a) Furnish and install factory assembled indoors and outdoors units of the types, sizes, capacities, and arrangements indicated on the drawings and specified herein.

(b) Install in accordance with the manufacturer instructions.

(c) The installation company shall be Approved Manufacturer Installers, whose installation engineers shall have attended the relevant Manufacturer equipment courses. Proof of compliance may be requested before commencing works. Approval is given by a Manufacturer Distributor. The tendering contractor must state on his tender return submission the name of the specialist Manufacturer approved sub-contractor to be employed to carry out the variable refrigerant air-conditioners units installation.

(d) Install units level and plumb.

(e) Install evaporator-fan components using manufacturer’s standard mounting devices securely fastened to building structure.

(f) Install ground-mounting, condenser components on 100-mm-thick, reinforced concrete base; 100 mm larger on each side than unit. Concrete, reinforcement, Coordinate anchor installation with concrete base.

(g) Install seismic restraints.

(h) Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 25 mm. Supply units fully charged with refrigerant and filled with oil.

(i) Install and connect pre-charged refrigerant tubing to component’s quick-connect fittings. Install tubing to allow access to unit.

(j) The installation of all indoor and outdoor units, refrigerant pipe work, interconnecting wiring, testing shall be carried out by the above stated approved Manufacturer Installer.

(k) The approved Manufacturer specialist refrigeration installer or/and a Manufacturer Distributor’s representative shall carry out/or witness the commissioning of the variable refrigerant air-conditioning-heat pump system and final inspection and record data as listed below:

(i) Record Pressure Test (Holding Pressure).

(ii) Confirmation of Record Drawings.

(iii) Record Pipe Lengths.

(iv) Record Pipe Diameters.

(v) Additional and Total Refrigerate Volumes.

(vi) Addressing of Fan Coils.
(vii) Cooling Start up Check.
(viii) Heating Start up Check.
(ix) Complete and issue Documents and Certificates to Consultant/Client.

(l) Should it deemed necessary full access should be afforded to the site during the installation of the variable refrigerant air-conditioning-heat pump to allow a Manufacturer Distributor’s representative/engineer to verify that the installation methods being used comply and are fully in accordance with the Manufacturer variable refrigerant air-conditioning-heat pump Installation Instructions, requirement in order that the equipment warranties will not be invalidated.

2 Connections

(a) Supply, install, test and commission all interconnecting refrigeration pipe work between the outdoor unit and the connected indoor units.
(b) Retain subparagraph below for units with remote water-cooled condenser.
(c) The pipe work installation, charging, testing and commissioning shall be carried out by REFCOM registered refrigeration engineers, who shall be fully trained in the safe handling of refrigerants and CITB trained in brazing techniques.
(d) Retain subparagraph below for units with steam coils.
(e) The installation shall be fully in accordance with British Standard BS EN378: 2000 Parts2-3 and Manufacturer design and installation instructions listed in the variable refrigerant air-conditioning-heat pump Installation Instructions.
(f) All pipe work installations shall be carried out in refrigerant quality soft or half hard drawn copper tubing to BS2871 Part 2: 1972 and complete with the appropriate refnet headers and refnet joints (as manufactured and supplied by Manufacturer).

<table>
<thead>
<tr>
<th>Step</th>
<th>Pressurize to</th>
<th>3 minutes or longer</th>
<th>Allows discovery of major leaks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>10.3 Bar (149 Psi)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>21.5 Bar (312 Psi)</td>
<td>5 minutes or longer</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>38 Bar (551 Psi)</td>
<td>Approx 24 Hours minimum</td>
<td>Allows discovery of minor leaks</td>
</tr>
</tbody>
</table>

(g) Required copper tube material is Phosphorus deoxidized copper seamless tube according to (JIS H3300 C1220T), Chemical composition in % CU 99.90 or over P 0.015-0.040 and Mechanical Characteristics (Quality classification : 0, Tensile strength 205 N/mm2 or over, Elongation 40% or over).

(h) Insulating Material: Chemical cross-linked 30-time foamed polyethylene
(with grained surface) in accordance with JIS A9511 PE-C-P2.

(i) Longest possible lengths of copper pipe shall be utilized to minimize the number of joints on site; appropriate refrigeration installation tools must be utilized to avoid the use of elbows. Oxygen free dry Nitrogen (OFN) must be in the system during brazing (no cold brazing is allowed).

(j) Pipe work shall be properly and neatly fixed and supported at a minimum of 2-meter intervals and where possible should be run on galvanised cable tray. All pipe work to be tagged with ID number (Condensing Unit ref) at 3-meter intervals.

(k) Pipe supports shall not restrict expansion or contraction of the pipe and restraint must not be applied to Refnet joints or Headers.

(l) All pipe work (suction and liquid) to be insulated with slip on close cell electrometric pipe insulation (as manufactured by Arm flex or equal and approved), fire rated to Class "O" Building Regulations 1985, with a wall thickness of not less than 13mm. Insulation must be protected when exposed to atmosphere by special paint or covered by an enclosure.

(m) All joints, after pressure and leak testing, are to be properly glued and or taped as to provide a complete seal to prevent any condensation, and shall be clearly marked for ease of identification.

(n) After installation of pipe work, prior to connection to the condensing units, sealing of insulation joints and starting of equipment, pipe work should be pressure tested using oxygen free dry nitrogen as outlined below to 38 Bar (551 Psi), held for 24 hours and checked for leaks.

(o) The system shall then be vacuumed/dehydrated to 0.2 torr (-755mmHg) and held at that setting for 1 hour (minimum) to 4 hours depending on pipe length using a 2-stage vacuum pump. All of the above works shall be carried out before electrical connection is made to the indoor units.

(p) The additional refrigerant (R410A) charge shall be calculated and weighed to accommodate the actual installed and measured length of pipe work all in accordance to Manufacturer recommendations and instructions listed in the variable refrigerant air-conditioning-heat pump Installation Instructions.

(q) The charging should be carried out with an appropriate charging station in the liquid phase and under supervision.

(r) Install piping adjacent to unit to allow service and maintenance.

(s) Retain first paragraph below for units connected to ducts. Coordinate duct installation requirements with schematics on Drawings and with requirements specified for duct systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

(t) All control wiring is to be carried out in 2 core 0.75mm2 - 1.25mm2 PVC non screened CY flexible control cabling to BS6141 and BS6500 (To comply with CE Regulations 1995) colour coded and separately marked at 2 meter intervals for ease of identification and maintenance.

3 Field Quality Control
(a) Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

(b) Perform the following field tests and inspections and prepare test reports:

   (i) Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   (ii) Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   (iii) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

(c) Remove and replace malfunctioning units and retest as specified above.

4 STARTUP SERVICE

(a) Engage a factory-authorized service representative to perform startup service.

   (i) Complete installation and startup checks according to manufacturer's written instructions.
3. UNITARY EQUIPMENT

3.1 GENERAL

3.1.1 Related Documents

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

3.1.2 Scope

1 Furnish and install split type room air conditioners as required by the contract and as specified.

2 Extent of the units is indicated on Drawings.

3 Related Sections are as follows:

(a) Section 1 General
(b) Section 21 Electrical Installation

3.1.3 Quality Assurance

1 Standards compliance: comply with requirements of applicable local codes and the following:

(a) Underwriters Laboratories: the units must be listed and labelled by UL.

(b) ARI: certify that the capacities of each model and size are in compliance with industry standard individual split air conditioning.

(c) ARI: test and rate each model and size for sound in accordance with industry standard 443-71 for sound ratings of air conditioners.

(d) ARI 210: unitary air conditioning equipment.

(e) ARI 270: sound rating of outdoors unitary equipment.

(f) Guarantee each unit to operate at the certified sound levels. Replace any unit, which does not fulfil this requirement.
3.1.4 Submittals

1 Submit the following for approval in accordance with the Contract, and Section-1 specification Parts.
   
   (a) Product Data: Provide manufacturer’s performance data such as printed technical literature, installation instructions, catalog and Certified coils and fan performance ratings.
   
   (b) Shop Drawings: Provide certified drawings showing overall dimensions, weights, required clearances, etc.
   
   (c) Installation and start up instructions and operating and maintenance manuals.

3.2 PRODUCTS

3.2.1 Split Type Room Air-conditioners

1 The unit offered in the tender shall be by a reputed manufacturer who is represented locally and can provide an efficient maintenance and spare part service and shall consist of two (2) sections. The first which is installed outside the building shall contain compressor, condenser and condenser fan, condenser motor, suction/ discharge outlets and the second which is installed inside the conditioned space shall contain evaporator, evaporator fan, filter and control unit. The evaporator unit must be fitted with thermal and sound insulation to the whole assembly and three (3) speed motors. For the ducted type evaporators units shall be supplied complete with return plenum, ductwork, supply and return outlets. Static pressure shall be as indicated on the drawings.

2 The outdoor unit casing shall consist of a heavy gauge steel chassis with sheet metal casing. The whole unit shall be protected against corrosion and finished inside and outside with stoned primer and paint.

3 The casing for the indoor unit shall consist of rigid plastic as supplied by the manufacturer.

4 The fan shall be of the forward curved centrifugal type and be made of aluminum, reinforced glass fibre or rigid plastic material.

5 The air filters shall be of nylon fibre glass fibre material as supplied by the manufacturer and approved by the Engineer.

6 The filter shall be easily removable for cleaning.

7 The inside unit fan and condenser fan motors shall have factory lubricated bearings of the sealed for life type.

8 The motor winding and electrical components shall be impregnated or protected to avoid problems with condensation.
9 The compressor in the outside unit shall be the hermetically sealed pattern complete with resilient mountings.

10 The condenser and evaporator coils shall be formed of copper primary tubes with aluminium fins, the fins shall be mechanically bonded to the tubes.

11 The units shall be installed in accordance with the manufacturer’s recommendations to unit location, refrigerant piping, power and condensate piping.

12 Where the units are of the concealed type the Contractor shall ensure adequate access is provided for the removal of a complete unit.

13 The condensate pipe work shall be run to the nearest drain as per drawings.

14 The units shall meet the specified duties for air flow and cooling capacities.

15 The controls shall include the following:

(a) Pressure switches.  (b) Remote control
(d) Thermostat.  (c) Thermal overload cut-out

16 The air conditioning unit shall be capable of operating in ambient conditions of 50 °C.

17 The sound level shall not exceed specified in parts 4 when measured at 1 m distance in a room with normal occupancy and furnishing.

18 The safety devices for the compressors shall be as per the manufacturers Recommendations.

19 The unit shall have control giving three running speeds and an off position. Refrigerant must be 410 or Equal Approval.

20 Unit shall be complete with the required length of insulation refrigeration piping as indicated on the drawings.

21 The indoor unit shall be equipped with an operation switch, fan speed selector switch and a thermostat mounted on the remote control switch for wall mounted units and concealed type. The operation switch shall have the function of OFF-FAN-COOL. The operation control shall conform to manual starting, automatic continuous operation whenever the thermostat requires and protection devices allow. The unit shall be restarted by resetting the operation switch if any one of the protection devices trips.

22 The magnetic switch box incorporated in the outdoor or indoor unit shall contain magnetic contactor for all motors, including condenser fan motor, over current relays and auxiliary relays.
3.2.2 Refrigeration Pipe Works

1. Supply, install, test and commission all interconnecting refrigeration pipe work (Liquid & Suction Lines) between the outdoor unit and the related connected indoor unit.

2. The pipe work installation, charging, testing and commissioning shall be carried out by registered refrigeration engineers following split units manufacturer recommendations and installation instructions, who shall be fully trained in the safe handling of refrigerants and CITB trained in brazing techniques.

3. The installation shall be fully in accordance with Manufacturer design and installation instructions.

4. All pipe work installations shall be carried out in refrigerant quality soft or half hard drawn copper tubing and complete with the appropriate accessories (as manufactured and supplied by Manufacturer).

5. Required copper tube material is Phosphorus deoxidized copper seamless tube according to (JIS H3300 C1220T), Chemical composition in % CU 99.90 or over P 0.015-0.040 and Mechanical Characteristics (Quality classification : 0, Tensile strength 205 N/mm2 or over, Elongation 40% or over).

6. All refrigerant piping shall be supported to prevent deflection, buckling and vibration.

7. Piping shall be supported at all changes in direction and at intervals of not more than 1.5 meters on straight runs. Pipe supports and clamps shall be subject to approval of the Engineer.

8. Pipe work on roof shall be supported on off-set clamps, floor.

9. The pipe support stands shall be bolted to the concrete slab/base.

10. Condensate drain pipe supports shall be capable of vertical adjustment after installation of piping.

11. All pipe work passing through the walls, floors and roof slabs shall be provided with pipe sleeves of adequate size to allow the passage of insulation.

12. Interior Insulation Application Schedule for Refrigerant Piping
   
   (a) Service: Refrigerant suction and hot-gas piping.
   
   (i) Operating Temperature: 2 to 10 deg C.
   
   (ii) Insulation Material: Flexible elastomeric.
   
   (iii) Insulation Thickness: Apply the following insulation thicknesses:
   
   (iv) Pipe, all sizes: 19 mm.
   
   (v) Field-Applied Jacket: None.
(vi) Vapor Retarder Required: No.
(vii) Finish: None.

13 Exterior Insulation Application Schedule For Refrigerant Piping

(a) Service: Refrigerant suction.
   (i) Operating Temperature: 2 to 10 deg C.
   (ii) Insulation Material: Flexible elastomeric.
   (iii) Insulation Thickness: Apply the following insulation thicknesses:
   (iv) Pipe, all sizes: 19 mm.
   (v) Field-Applied Jacket: Aluminium.
   (vi) Vapor Retarder Required: No.
   (vii) Finish: None.

3.3 Execution

3.3.1 Installation

1 All units must be earthed.

(a) Units shall be installed in accordance with manufacturer installation instructions and Drawings.
(b) Provide shop drawings indicating the location of the oil separator before installation.
(c) Provide clearances for servicing and maintenance.
4. AIR HANDLING EQUIPMENT & HEAT RECOVERY

4.1 AIR HANDLING UNITS

4.1.1 General

1 Related Documents

(a) The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section.

(b) Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

(c) Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

2 Scope

(a) Furnish and install air handling units as required by the contract and as specified.

(b) Extent of air handling units is indicated on Drawings.

(c) Related Parts and Sections are as follows:

3 Quality Assurance

(a) UL compliance: Fans shall be designed, manufactured, and tested in accordance with UL 705 “Power Ventilators”.

(b) NEMA compliance: Motors and electrical installation shall comply with NEMA standards.

(c) Electrical Component Standard: component and installation shall comply with NFPA 70 “National Electrical Code”.

(d) BS 746 Gas meter unions and adaptors

(e) BS 2831 Methods of test for air filters used in air conditioning and general ventilation

(f) BS 3120 Performance requirements of flame proof materials for clothing and other purposes

(g) BS 3928 Method for sodium flame test for air filters (other than air supply) to i.c engines and compression

(h) ASHRAE Standard 52-68
4 Submittals

(a) Submit the following for approval in accordance with the Contract, and Section-1 Specification Parts.

(i) Product Data: Provide air handling manufacturer's performance data such as printed technical literature, installation instructions, catalog and Certified coils and fan performance ratings.

(ii) Shop Drawings: Provide certified drawings showing overall dimensions, weights, required clearances, locations of connections and support requirements.

(iii) Installation and start up instructions and operating and maintenance manuals.

(iv) Test Reports: Provide report and certification from manufacturer or approval testing laboratories as required by Engineer.

(v) Certifications

(vi) Provide AMCA certified ratings for fans and ARI certified ratings seal for coil and casings or approved equal by engineer

4.1.2 Products

1 General

(a) Factory-built air handling units shall be either horizontal or vertical type with required sections and coil capacities as listed in the Section entitled "Bill of Quantities" and as indicated on Drawings.

(b) Unless otherwise noted each air handling unit shall be complete with casings, centrifugal fan, insulation, drain pan, cooling and heating coils, filters, plenums, mixing box, fan motor with adjustable bases, adjustable pulleys, belt drives and outlet flange.

(c) Also units shall be complete with a round poly-carbonated inspection window for the motor belts together with a weather-proof bulkhead luminaries and switches.

(d) All units installed outside the building shall be supplied with factory installed sunshade cover and weather-proof canopy.

(e) The units shall be installed to allow adequate access for the withdrawal of tubes, fan shafts, coils or other items for replacement or maintenance.

(f) The internal surfaces of panels and frames shall be treated to prevent migration of particles into the air stream and to minimise the possibility of damage.

(g) The overall dimension and weights shall be such that the units of sub-assemblies can be moved to their ultimate position on site through existing openings or, where possible, prearranged access ways.

(h) All pipe inlets and outlets are to be sealed to prevent ingress of air moisture and foreign bodies.
(i) Checks shall be carried out to ensure the frames are not distorted or twisted on arrival and, subsequently, after each every removal to another part of site. In addition checks shall be made of individual sections of equipment.

(j) All associated control systems and wiring shall be provided with adequate protection against ingress of dirt and moisture.

(k) Physical checks shall be made on all bases that have been provided for all equipment and on the installation of the equipment on the bases, to ensure correct level and alignment.

(l) Where air handling units have to stand for long periods prior to use, the manufacturer shall be consulted as to any precautions to be taken. This may include rotating the fan impeller by hand at regular intervals to avoid a permanent set in the fan shaft owing to deflection and complete re-lubrication before start-up.

(m) Fresh air intakes shall be as remote as possible from concentrations of surface or roof dirt and positioned to avoid the intake of fumes and odours.

(n) The fresh air inlet shall be positioned at least 1.2 m above ground level.

(o) The control system and wiring shall be provided with adequate protection against ingress of dust and moisture.

(p) All air handling unit sections shall be produced with heavy duty lifting lugs

(q) The units shall include a mixing box section when required. The mixing box section shall include factory installed dampers.

2 Unit Casing

(a) Each unit shall have an airtight sectionalized double skin casing constructed of thermal break extruded anodized aluminium support frame assembled without welding joints on galvanized steel base frame. The panels shall be entirely insulated, 50 mm thickness, the outer face shall be plasticized with plastic coating thickness 120 micron, inner surface shall be galvanized sheet, sheets thickness shall be not less than 1.0 mm. The panels shall be assembled to the frame with multi teethed neoprene gaskets and fixed with plated screw in nylon bushing protection. Casing shall contain fan sections, coil sections, filter sections and other sections in modular sections indicated on the drawings.

(b) Coil section shall completely enclose all connections, coil, headers, and return bends. Coil frames shall not be used as structural members of the coil section. The coil section shall be constructed in such a manner that the coil can be removed without affecting the structural integrity of the casing, on rollers and rails or approved sliding method.

(c) The drain pan shall extend under complete coil section and shall be rigid, insulated and watertight with pipe drain connection.

(d) The drain pan shall be constructed no less than 1.2 mm stainless steel. It shall be rigidly supported by galvanized heavy duty frame.
(e) Doors shall be located so that the unit may be inspected or entered regardless of mounting arrangement. Door insulation shall be separate from unit insulation and shall be secured and sealed as specified for unit casing insulation. Doors shall be equipped with airtight handles.

(f) All casing panels shall be insulated with at least 50 mm thick, 48 kg/m3 density rigid fibre glass with a k-factor not exceeding 0.037W/m2/K. Injected polyurethane can be used instead, provided that the overall heat transfer coefficient does not exceed the above construction.

(g) Frame shall be insulated such that condensation does not occur due to the formation of cold bridges under adverse ambient conditions

(h) Space between coils shall not be less than 500 mm. An access door shall be provided in this space.

(i) All performance ratings presented by manufacturers shall be verified by tests Certification from EN 1886: “Ventilation for buildings – Air Handling Units – Mechanical performance”. The following mechanical characteristics shall be certified:

   (i) Casing strength (CS) - D1.
   (ii) Casing air leakage (CAL) - L1.
   (iii) Filter by-pass leakage (FBL) - F9.
   (iv) Thermal transmittance of the casing (TT) - T2.
   (v) Thermal bridging factor (TBF) – TB2.
   (vi) Acoustical insulation of casing - Achieving required noise criteria.

3 Fans, Shafts and Drives

(a) General

   (i) The fans installed in all AHU shall comply with all relevant QGEWC regulations.

   (ii) The type of fan installed in each AHU shall be as detailed in the Project Documentation.

   (iii) Flexible connection shall be installed on the supply, return and fresh air ducts to minimise vibration transmission to the adjacent ductwork.

   (iv) The complete fan and motor shall be installed on a rigid frame. The frame will be supported by properly sized anti-vibration spring mounts to isolate the motor and fan from the units casing.

   (v) Where the fan volume or static pressure is to be variable; variable speed frequency drive shall be incorporated as detailed in the Project Documentation.

   (vi) The external pressure calculations shall be submitted by the contractor along with the AHU submission on order to select the suitable motor.
(vii) Fan and motor drive shall be oversized by at least 20%.

(viii) The motors shall be connected with flexible electrical connections.

(b) Centrifugal fans:

(i) Centrifugal fans shall be double width, double inlet multi blade type with backward blades, or otherwise specified and made all from fabricated steel protected with two coats of rust inhibiting paint.

(ii) Fan casings shall be constructed of mild steel plates with angle stiffeners and base angles to ensure freedom from drumming and shall be suitable for operation at the maximum static pressure of the system. The whole assembly shall be treated for resistance to corrosion.

(iii) Fan casings shall be constructed so that impellers can be easily hand driven after installation.

(iv) A drain plug shall be fitted to the fan casing at its lowest point.

(v) Fans, sheaves, motors and belts shall be factory assembled. Unit shall be dynamically balanced. The contractor shall conduct a vibration test on all units after they have been installed in the field. Vibration shall not exceed 2.0 mils and shall be so certified by the contractor in writing prior to putting unit in service.

(vi) Fan shafts shall be one-piece design either solid or hollow tube with solid stub. Two-piece shafts shall not be acceptable. Hollow tube with solid stub as shafts. Fans shall not be cantilevered. Fan shafts shall not pass through their first critical speed as the unit comes up to rated rpm.

(vii) Fan shall have externally or internally mounted grease-lubricated self aligning ball bearings on each end of the shaft. Bearings shall have an average life of 200,000 hours at design operating conditions. Life lubricated sealed bearings shall not be acceptable. Shafts with internal mounted bearings shall have grease lines extended so as to be readily accessible from the filter end or drive side of unit. In addition, the bearings on the drive end of the shaft shall have a grease line extended beyond the belt side. All grease lines shall terminate in a zerk fitting.

(viii) Fan drives shall be selected with a minimum belt horsepower capacity of 200% of the motor nameplate horsepower. All drives shall conform to tolerances as set forth in "Engineering Standards for Multiple V-Belt Drives-1982" as adapted by the Mechanical Power Transmission Association, and Rubber Manufacturers Association, Inc. Fan drive selection calculation shall accompany the drive submittal data for review. The selection calculations shall include the corrosion factor for arc of contact. The fan drive components shall be as follows:

1. The motor sheaves shall be adjustable type with double locking feature. Motor sheave shall be selected for the rated fan
capacity requirements scheduled and shall be adjustable as close to 10% above and below the rated fan speed as possible.

2. The fan sheaves shall be non-adjustable type with removable machined bushing. The sheaves shall be machined on all contact surfaces. Fan sheaves with more than three grooves shall be dynamically balanced on each sheave. Fan sheaves with three grooves or less shall be statically balanced. If weights are required for balancing, they shall be welded to sheave.

3. The belts shall be standard "V-groove" type suitable for the service intended with the capacities specified herein before. All belts shall be closely matched and tagged prior to delivery to the job site. If in the opinion of the Engineer, the belts do not appear to be properly matched during operation, they shall be rechecked, if necessary replaced with another closely matched set of belts.

4 Motors

(a) Motors shall be selected so that they shall not overload if the static pressure drops 25% below the specified operating value.

(b) Motors shall be mounted on the coil connection side unless indicated otherwise on the Drawings.

(c) Each motor shall be mounted on an adjustable base rigidly supported to the unit.

(d) Motor shall have an extended shaft to accommodate the adjustable pitch motor sheave specified herein. See the Section entitled "Electric Motors and Controllers" for motor specifications. Motor controller shall be furnished and installed by the Contractor. All motors shall be suitable for variable frequency operation.

(e) Design and performance shall be in accordance with IEC Standards: Premium Efficiency Motors: IE3 as a minimum requirement.

5 Refrigerant Direct Expansion Coils

(a) The coils shall be provided with refrigerant distributors and the connections to the tubes shall be designed to ensure an equal flow of the refrigerant to each tube

(b) The suction connections shall be arranged so as to ensure complete drainage of any oil in the coil.

(c) The coils shall be dehydrated and sealed after manufacture.

(d) The coils shall be tested to 1.5 times their maximum working pressure.

(e) The thermostatic expansion valve which shall incorporate an external
equaliser line shall maintain the design degree of super heat at the evaporator outlet. The remote sensing bulb shall be securely fixed to the evaporator outlet piping in a position where the degree of superheat can be correctly sensed.

(f) The design evaporating temperature shall not be less than -1 °C.

(g) The coil shall be sized to be compatible with the associated refrigeration equipment.

6 Electrical Heaters

(a) The casing shall be of galvanized sheet steel no less than 1.2 mm thick with angle framing drilled and ready to receive the counter flange on the duct work. Alternatively, the construction shall be compatible to fit within the air handling unit where appropriate.

(b) The electric heaters shall consist of a number of helically coiled nickel chromium alloy heating elements of the enclosed non-corrodible type mounted in the sheet steel casing.

(c) The elements shall be so installed that they can be removed for cleaning or removal with minimum disturbance to other plant items.

(d) The surface temperature of the elements shall not exceed 150 °C.

(e) The control of electric air heaters shall be inter locked with the fan motor starter and air flow switch so that the heater cannot operate unless the fan is running and air flow is detected.

(f) All heaters and heater sections greater than 3 kW loading shall be balanced over three phases and the complete heater bank shall be arranged for balanced operation on a 3-phase 4-wire system.

(g) The connections from each element shall be taken to readily accessible terminal box arrange for conduit entry.

(h) Each heater section shall be separately fused and the neutral point of a all 3-phase star-connected section shall be brought out to a link in the terminal box.

(i) The insulation of the wiring near any hot areas shall be of the appropriate quality.

(j) The installation of electric heaters batteries shall comply in all respects with the requirements of the Civil Defence Department and QGEWC regulations.

7 Dampers

(a) Dampers shall be mounted as a single assembly. Blades shall have opposed movement by matching gears on both ends. Dampers shall be sectionalized to limit blade length to 1 m or prevent excessive blade warping. Edges shall have closed cell gasket to assure tight closure. The dampers shall be designed for the rated air flow velocity not to exceed 4 m/s.
(b) Dampers shall be of rigid construction and should not rattle. Shut off dampers shall provide an effective seal to minimise air leakage.

8 Filter Sections

(a) Cleanable Filters: The cleanable filters shall be made of expanded aluminium foil filter panels, panels are constructed from multiple layers from expanded aluminium foil mesh. The layers must be arranged at a right angle one to the other which shall allow the air to change its direction several times achieving maximum impingement with low resistance to air flow. Construction shall be in statiform layers that shall not allow compression or collapse for the filter under air flow or dust load. Each layer of expanded aluminium mesh must have joint-less continuity and cannot shed any loose fibbers or strands. Filter shall be 50 mm thick with 73% efficiency with ASHRAE Dust Test, and shall have 85% efficiency with ASHRAE mean Gravimetric Efficiency of Separation, and it must have a minimum dust holding capacity of 1550 g/m. Clean filter shall not have more than 5 mm wg pressure drop when air is passing over the filter with a velocity of 2 m/s. Filter must be fire resistant and must be tested for fire spread test BS 476-Part 7-1971, and must achieve at least Class 1. Each bank of filters must have a U-Tube Manometer connected to each side of the filter to determine the pressure drop.

(b) Bag Filters: Bag filters shall be completed with its frame and mounting frame. Filter media shall be made from high quality fiberglass media to separate fine dust, suspended particles, and aerosols. Filter case shall be made from galvanized sheet steel with standard cell frame for mounting the bag filters. Case shall have a side service door for changing filter media from dirty side. Filter shall be checked for media stability caused by the unsuitable installation condition or unfavorable flow conditions resulting in a marked mechanical overloading of the filter media especially at the intake cross-section of the bag filter. Filter shall be checked also for durability. Filter must have an efficiency of 85% when tested with ASHRAE Standard 52-76. Pressure drop through filter when clean must not exceed 120 Pa wg. Filter length when used for supply air shall be 600 mm. Each bag filter must have a pressure controller for indicating and control of pressure differential, with electrical signaling when the fixed setting of pressure differential has been exceeded. An inclined gauge manometer of acrylic glass shall be used. The electric signal is sent to the relay via an amplifier with high sensitivity switching, when the said value has been reached. The relay makes the switching contact for remote signals, and operates with make and break leg, so as to avoid on/off switching at short intervals. The relay must be connected to an indicating lamp on the control panel of the air-handling unit and to a loud bell. The pressure controller must be supplied with measuring fluid on a fluid container with capillary tube to avoid loss of fluid in any position. Pressure controller must be able to have two different scales one from 0-400 Pa wg, and the other from 50-1250 Pa wg by changing the position of the pressure control.

9 Heat Recovery Units
(a) Heat Pipes For Heat Recovery

(i) Energy recovery heat pipes shall be included within the AHU or within the supply and extract ductwork as specified. The heat pipe shall be a single section and will straddle the airways in the supply and extract decks of the AHU or the supply and extract ductwork.

(ii) The heat pipe shall be suitable for either side by side mounting between the two adjacent ducts (horizontal heat pipe) or top and bottom mounting with the warmer air always flowing through the bottom section (vertical heat pipe). The length of the heat pipes in the supply and extract section shall be selected so as to match the respective air volumes. The external fins shall be of aluminium with a minimum thickness of 0.15mm. Fins shall be of the continuous plate type and louvered type to optimize the airside heat transfer.

(iii) Tubes shall be of refrigeration standard seamless copper C106 for heat exchanger use. Tube diameter shall be 12mm with a grooved inner surface to enhance the internal surface area and minimum root thickness of the tube shall be 0.35mm. Casings shall be from galvanized sheet steel with a minimum thickness of 1.4mm. The casing shall incorporate tube plates, continuous side plates and a centre dividing plate to prevent cross-contamination between the two airstreams.

(iv) The working fluid shall be refrigerant type classified as ASHRAE safety group A1. The refrigerant shall be either R134a or as specified in project documents. The heat pipe circuits shall be factory charged and hermetically sealed with the calculated weight of refrigerant. There shall be a multitude of loops in the height of the heat pipe and each loop shall be individually charged. Heat pipes with header assemblies containing a single circuit are not suitable as a single leak will render the entire heat pipe inoperative.

(v) There shall be a multitude of loops in the height of the heat pipe and each loop shall be individually charged. Heat pipes with header assemblies containing a single circuit are not suitable as a single leak will render the entire heat pipe inoperative.

(vi) Heat pipes shall be designed to comply with the specified conditions when subject to the air volumes given in the project document.

(vii) Heat pipe performance shall be independently type tested and certified in line with the requirements of British Standards BS 5141 pt1 or European Standards EN 305 & 306 or American Standards ARI 410 for testing and rating of heat exchangers.

(viii) All software used to predict the performance of heat pipes shall be based upon the results of these independent tests.

(b) Horse Shoe (Wrap Around) Heat Pipes Specifications

(i) Heat pipes shall be included within the AHU and wrapped around the main cooling coil.
(ii) A minimum of 100mm gap should be allowed between the leaving face of the cooling coil and the entering face of the heat pipe reheat section. This gap will permit the installation of sensors or other instrumentation to monitor the condition of the air after the cooling coil.

(iii) The external fins shall be of aluminium with a minimum thickness of 0.15mm. Fins shall be of the continuous plate type and louvered type. Tubes shall be of refrigeration standard seamless copper C106 for heat exchanger use. Tube diameter shall be 12mm with a grooved inner surface and minimum root thickness of the tube shall be 0.35mm. Casings shall be from galvanized sheet steel with a minimum thickness of 1.4mm. The casing shall incorporate tube plates and top and bottom plates around both the precool and reheat heat pipe blocks.

(iv) The working fluid shall be refrigerant type classified as ASHRAE safety group A1. The refrigerant shall be either R134A or as specified in project documents. The heat pipe circuits shall be factory charged and hermetically sealed with the calculated weight of refrigerant.

(v) There shall be a multitude of loops in the height of the heat pipe and each loop shall be individually charged. Heat pipes with header assemblies containing a single circuit are not suitable as a single leak will render the entire heat pipe inoperative.

(vi) Heat pipes shall be designed to comply with the specified conditions when subject to the air volumes given in the project document.

(vii) Heat pipe performance shall be independently type tested and certified in line with the requirements of British Standards BS 5141 pt1 or European Standards EN 305 & 306 or American Standards ARI 410 for testing and rating of heat exchangers.

(viii) All software used to predict the performance of heat pipes shall be based upon the results of these independent tests.

(c) Independent Type Test Report

(i) The heat pipe should strictly have a third party independent type test report conducted by Eurovent certified laboratories like CETIAT (FRANCE) or BSRIA (U.K.) or approved equal.

(d) Rotary Heat Recovery Unit

(i) Heat exchangers shall be factory fabricated, assembled and tested according to manufacturer’s standard design; materials and construction are to comply with published information except as herein after indicated.

(ii) Heat exchangers shall have the capacities, types, sizes and services as shown on the Drawings.

(iii) The rotor matrix consists of aluminium foil, bond formed in waves and wrapped together with a straight bond on top of each other. In this way depending on the height of the waves flow through channels
are created in the different size according to the required efficiency and pressure drop. The rotor rotates with a maximum of fifteen times per minute in the case of full efficiency. By reducing the number of rotations, a reduction of the transmission power can be achieved. The air flows have to be in counter flows.

(iv) The heat exchanger shall be suitable for vertical and horizontal installation and this shall be possible for every size, also it shall be suitable for fitting in air conditioner or for direct connection to duct system.

(v) The housing dimension shall extend to fit within the air handling equipment and has to be as large to be 4 m long for both height and width.

(vi) The wheel has to be undivided up to a diameter of 2250 mm, and for bigger diameters the wheel may be divided without altering the overall performance of the heat exchanger.

(vii) The housing shall be stable continuous welded frame construction, made of galvanized steel. The construction of the casing shall be low weight and simple enough to allow access to all components.

(viii) The wheel shall be surrounded be adjustable and wear resistant seals completely adjacent round the wheel.

(ix) The bearing shall be maintenance-free antifriction type and protected by a surrounding hub.

4.1.3 Execution

1 Installation

(a) All units must be earthed.

(b) Units shall be installed in accordance with manufacturers installation instructions and as indicated on drawings.

(c) Provide clearances for servicing and maintenance.

(d) Inspection and performance tests shall be carried out on contractor expenses to the satisfaction of the Engineer.

2 Inspection

(a) The Engineer may observe the air-handling units for this project under manufacturing at the factory if he so desires. The Mechanical Contractor shall notify the Engineer in writing of the production schedule and dispatch date at least two weeks prior to the air handling unit production date.
6. DUCTWORK AND AIR-SIDE EQUIPMENT

6.1 SHEET METAL DUCTWORK

6.1.1 General

1 Related Documents

(a) The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

(b) Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

(c) Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

2 Scope

(a) Furnish and install sheet metal ductwork, dampers, auxiliary drain pans and all necessary accessories as required by the contract and as specified herein.

(b) Extent of sheet metal ductwork is shown on Drawings.

3 Reference Standards

All sheet metal ductwork or dampers shall be designed, manufactured and constructed in accordance with the following standard:

(a) BS 476 Fire tests on building materials and structures,

(b) BS 1449 Steel plate, sheet and strip,

(c) BS 1470 Wrought aluminium and aluminium alloys for general engineering purposes,

(d) BS 1474 Wrought aluminium and aluminium alloys for general engineering purposes; bars extruded round tubes and sections,

(e) BS CP 352 Mechanical ventilation and air conditioning in buildings,

(f) NFPA 90A Installation of Air Conditioning and Ventilating Facilities,

(g) NFPA 96 Ventilation Control and Fire Protection of Commercial Cooking Operation,

(h) SMACNA Ductwork design and installation,

(i) UL 555 S Smoke Dampers

(j) DW/I44 Specification for Sheet Metal Ductwork
4 Submittals

(a) Submit the following for approval in accordance with the Conditions of the Contract and Section-1 Specification Parts.

(i) Product Data: Provide manufacturer's product data, including printed technical literature, installation instructions and catalog clippings for sheet metal ductwork materials, specialties and accessories.

(ii) Manufacturer Certification: Provide all manufacturer certification that sheet metal ductwork or dampers comply with the required specifications.

(iii) Shop Drawings: Provide shop drawings for all sheet metal ductwork drawn to a minimum scale of 1:50. No fabrication shall be started before obtaining approval for these shop drawings. In addition to the layout of the ductwork, indicate the type of seams and joints, the method of applying acoustical lining and nosing, details of fire dampers and any other details the Engineer may request reference to sheet metal work. Indicate the elevation of bottom of ducts above finished floor on the Drawings.

6.1.2 Products

1 General

(a) All sheet metal ductwork in this project shall be of the low pressure type and shall be installed for satisfactory operation in accordance with the arrangements and sizes shown on the Drawings and any changes for duct sizes and location to meet field conditions and coordination between trades shall be done without additional cost to the owner.

(b) Ductwork shall be constructed of "Lock Forming" quality galvanized steel having a Zinc coatings on all ductwork galvanized steel ducts, zinc on the surfaces of the steel sheet in 275 g/m2, coating should applied to both sides of the sheet. Snap seam shall not be permitted.

(c) Ductwork for laboratory area shall be including all related accessories for exhaust shall be of PVC/Polyethylene/GRP. Contractor shall submit the material for Engineer's approval

(d) All galvanized ductwork covered U-V lambs shall be complete with additional aluminium sheet 0.4mm minimum thickness inside the duct for increased reflectivity. Access door shall be providing for service U-V lamb

(e) Fire rated ductwork and any other related component which services smoke fans, emergency exhaust fans and supply fans shall be UL listed, FM approved, or LPC certificated approved. The fire resistance rating shall be 2.5 hour’s at 300°C and minimum thickness shall be 1.2mm.

2 Duct

(a) Duct sizes indicated for internally lined ducts are the net duct dimensions and shall be increased in both dimensions by twice the thickness of the
linen.

(b) The interior surfaces of all ductwork shall be smooth. No sheet metal parts, tabs, angles or anything else project into the air ducts for any reason unless specified to do so. All seams and joints shall be external. Use gasketed type joint when dissimilar metals are joined.

(c) All galvanized ductwork shall be hung with galvanized hanging system.

(d) Tapers shall be constructed in accordance with SMACNA standards. When a taper is used in a "diverging" air flow and the duct size increases, the sides are to be pitched to a maximum of 20° to prevent turbulence or an additional increase of static pressure. When a taper is used in a "contracting" air flow and the duct size is decreasing, the sides are to be pitched to a maximum of 30°.

(e) When space conditions permit, full radius turns shall be used at offsets in low pressure ducts radius = duct width.

(f) Where space conditions do not permit a short radius, vaned elbows or square elbows shall be used. All share elbows shall be fitted with double thick turning vanes. For un-avoided obstruction passing through ducts shall be encompassed with a "Streamliner".

(g) Manual and control dampers, fire dampers, grilles, registers, diffusers, access doors, etc., shall be installed as indicated on Drawings, described elsewhere in the specifications and as required for a complete system ready for operation. Balancing dampers shall be installed in each branch, split or tap connection unless otherwise noted on Drawings.

(h) Zinc coatings shall be used on all ductwork galvanized steel ducts, minimum zinc on the surfaces of the steel sheet in 275 g/m², coating should be applied to both sides of the sheet.

3 Rectangular Sheet Metal Ductwork

(a) The rectangular ductwork shall have cross-breaking or mechanical transverse beading for ductwork sizes 300 mm and wider and shall be installed as indicated on the Drawings and as specified. Duct beading used to stiffen ducts shall be at least 1.5 mm deep at the center of the bead and a maximum of 5 mm wide at the base of the bead.

(b) Duct gauges in mm shall be as follows:

<table>
<thead>
<tr>
<th>DUCT WIDTH</th>
<th>SHEET METAL THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 750</td>
<td>0.7</td>
</tr>
<tr>
<td>751 to 1500</td>
<td>0.9</td>
</tr>
<tr>
<td>1501 to 2250</td>
<td>1.1</td>
</tr>
<tr>
<td>Over 2250</td>
<td>1.3</td>
</tr>
</tbody>
</table>

(c) Where possible, all ductwork shall be fabricated in such a manner that
seams and/or joints shall not be cut for the installation of grilles, registers, or ceiling outlets. If cutting of seams or joints is unavoidable the cut portion shall be properly reinforced to original strength.

(d) At all places where a duct divides, furnish and install splitter dampers constructed of 2 mm galvanized iron securely fastened to a square operating rod. The edges of the splitters shall be hemmed. Damper blade width shall be 1\(\frac{1}{2}\) times the smallest split. All splitter dampers shall be equipped with Ventlock, or approved equal, regulators and end bearings.

(e) At all places where rectangular branch ducts take off a main duct at less than a ninety degree angle, furnish and install a 2 mm galvanized iron splitter securely fastened to a square operating rod. Dampers shall be equipped with regulators and end bearing.

(f) All regulators mounted on externally insulated ductwork shall have 2 mm elevated platforms at least 3 mm higher than the thickness of the insulation. If duct is enclosed in a furring, or in an inaccessible ceiling, the operating handle shall be extended and the regulator installed on the face of the wall or ceiling.

4 Round Sheet Metal Ductwork

(a) Duct gauges, girth reinforcing, girth joints, longitudinal seams, shall be in accordance with the SMACNA Manual. Draw hand joint connection shall not be acceptable. Round duct over 1300 mm in diameter shall be a minimum of 1.6 gauge galvanized steel with welded joint construction and companion flange joints.

(b) Round elbows shall be constructed to have not less than the number of gores stipulated in the SMACNA Manual.

5 Flexible Connection

(a) Flexible connection shall be provided in ductwork connected to the inlets and/or outlets of all air handling equipment. The material shall be classified by underwriters laboratories as non-combustible for the fabric and glued. Sewing or stapling shall not be permitted, at least 25 mm slack shall be allowed in all flexible connection installations to ensure that no vibration is transmitted.

6 Ductwork Hanger and Supports

(a) All ductwork shall be properly suspended or supported from the building structure. The duct hanging system is composed of three elements: the upper attachment to the building, the hanger itself, and the lower attachment to the duct. The attachments, hangers, and supports for all ductwork shall be in accordance with the SMACNA Manual.

(b) Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, Chapter : 5 Hangers & Supports " Table 5-1M, "Rectangular Duct
Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

7 Flexible Ductwork

(a) Flexible duct shall be provided in ductwork connected to various air outlets, etc., as shown on Drawings.

(b) Flexible duct shall be factory-insulated assembly constructed of machine wound spiral aluminium helix of reinforced aluminium foil and fiberglass fabric mechanically locked into a spiral aluminium helix. It shall require no more than two (2) 90° elbows as installed. The flexible duct assembly shall be listed by the Underwriters Laboratory at a flame spread of not over 25 and a smoke developed rate of not over 50 and shall comply with NFPA Standard 90A.

(c) Oval ends on spiral aluminium helix flexible ductwork, which may be required to connect to various air distribution devices, shall be factory fabricated. At the contractor's option oval ends may be field-fabricated on special mandrels subject to the review of the Engineer.

(d) Flexible ducts shall be a factory-insulated assembly consisting of a plastic non-perforated sleeve fused to a galvanized steel wire helix. The jacket shall be vapour proof. None of the material shall support combustion. The flexible duct assembly shall be listed by the Underwriter's Laboratories at a flame spread of not over 25 and a smoke developed rate of not over 50 and shall comply with NFPA Standard 90A. Maximum length of flexible duct shall be 2.5 m. It shall require no more than two (2) 90° elbows as installed.

(e) The length of flexible ductwork shall not exceed 2 m per section and shall be supported as recommended by the manufacturer.

8 Fire Dampers

(a) Furnish and install fire dampers at ducts penetrating fire resistant walls, slabs, shafts and at all locations as indicated fire rated in life safety drawings, required and/or herein specified.

(b) Provide fire dampers in all duct over 125 cm² in area, in the following locations, whether or not specifically required by ordinances and codes and as indicated the contract drawing:

(i) Duct entering and leaving fire shafts (duct shafts)
(ii) Ducts passing through designated fire walls
(iii) Ducts through floors, and not encased in fire shaft
(iv) Ducts leaving and entering plant area
(v) Ducts entering and leaving storage areas.
(c) Where fire dampers are located remote from fire partition, duct between fire damper and partition shall be encased in double metal lathe and plaster or other fireproofing acceptable to Authorities having jurisdiction. This shall be arranged and paid for by this trade.

(d) Fire dampers shall not be installed in kitchen exhaust ductwork. This shall comply in all respects with NFPA 96.

(e) Fire dampers shall be labelled by the Underwriters Laboratories and shall meet the requirements of the current edition of NFPA Pamphlet No. 90A or approved equal. Fire dampers shall be constructed and installed as follows:

(i) Fire dampers shall be installed where ducts pass through fire walls or area separation walls. Dampers shall be installed at the fire wall and shall be of the folding blade curtain type with fusible link.

(ii) Fire dampers must be approved by Qatar Civil defence and Engineer and shall be installed in sleeves in accordance with manufacturer instructions.

(iii) Dampers shall be actuated by approved fusible link. Upon operation of the link, the dampers shall close automatically and remain tightly closed.

(iv) Fusible links shall operate approximately 10°C above the maximum temperature the duct system shall encounter under normal operation, but not less than 72°C, unless otherwise noted on the Drawings.

(v) Fire dampers shall be equipped with stainless steel spring catches.

(vi) Provide hinged duct access door for inspection and servicing of dampers.

(vii) Damper operation shall be tested after the installation is complete. A written certificate shall be issued by the contractor stating the identification of damper as to location, date tested, and names and signatures of testing personnel.

(f) Minimum fire damper resistance rating should be at least 2 hours at 250°C.

(g) The fire sealant shall be at least equal to the elements of structure or wall.

(h) Damper operation shall be tested after the installation is complete. A written certificate shall be issued by the contractor stating the identification of damper as to location, date tested, and names and signatures of testing personnel.

9 Manual Damper

(a) Manual dampers shall have aluminium channel frame with mounting flanges. Axles shall be of geared type and shall be interlocked with blades to positively eliminate slippage.

(b) Blades shall be of airofoil aluminium shape. Manual dampers shall have a minimum of four (4) blades running the entire length of the damper to assure rigidity and tight shutoff. Blades shall be on centers not greater than
150 mm and no blade shall exceed 1200 mm in length. All blades shall be interconnected and in unison for opposed blade operation.

(c) When installed, damper frame shall be gasketed or caulked to eliminate leakage between duct and damper frame. Head and sill shall have stops. Damper shafts shall be marked with blade operation.

(d) Dampers shall be provided with locking quadrants of sufficient size and design to securely hold the damper sections and blade linkage hardware.

10 Splitter Damper

(a) Adjustment splitter or deflecting damper shall be fitted at each point of division in a supply duct, where a branch is taken off a trunk.

(b) Splitter damper shall be double skin type, galvanized steel blade (two gauges heavier than the duct), shaft minimum diameter 10mm, and control rod minimum diameter 6mm.

(c) The damper is controlled by turning the handle which causes the damper blade to travel along the plated threaded rod the damper control, which is the self locking type, is fixed by tightening the hexagonal brass acorn nut.

(d) Deflecting dampers shall be permanently set be locked in position after completion of the installation and adjustment.

11 Damper Quadrants

(a) All dampers other than dampers behind registers, diffusers shall be fitted with substantial locking cast metal quadrants.

(b) Quadrants shall be mounted outside the duct in an accessible position.

(c) On insulated ducts, the quadrants shall be fastened to bearing plates flush with the outside finish of the insulation.

12 Motorized Dampers

(a) The Contractor shall furnish and install, control dampers as required for the proper functioning of the system.

(b) All control dampers shall be opposed blade.

(c) Dampers frames shall be formed channels of not less than 1.8 mm galvanized steel with mounting holes for enclosed duct mounting.

(d) Damper blades shall be of not less than 1.5 mm form galvanized steel. Blades on multi-blade dampers shall not exceed 200 mm in width and 1200 mm in length. Blade shaft bearings shall be provided at the ends of each blade. Blade side edges shall seal off against spring stainless steel seals.

(e) Dampers shall be supplied in standard sizes, in 50 mm even increments, with transition as necessary to mating duct sections.

(f) Dampers shall be suitable for operation within the temperature limit of – 40 oC to 93 0C. Horizontal dampers shall have a rated face velocity of 2 m/s at
1500 Pa static pressure differential.

(g) Dampers used for shut off function shall be of the low leakage type.

(h) Damper blades shall have neoprene or PVC edging on all outside air dampers.

13 Smoke Dampers

(a) Smoke dampers shall be the low leakage type, rated under UL 555 S as leakage Class I.

(b) Frame shall be of formed channel of not less than 1.6 mm galvanized steel. Blades shall be 1.6 mm, airfoil shaped, double skin construction, opposed blade type.

(c) Blade edge seals shall be silicon rubber and jamb seal shall be flexible metal compression type.

(d) Bearings shall be stainless steel sleeve type pressed into frame.

(e) Damper actuators shall be factory furnished suitable for either 240 volt or 24 volt application. Complete unit shall be factory tested in compliance with UL 555 S.

(f) Damper and actuator shall be qualified under UL 555 S to an elevated temperature 120 °C.

(g) The damper unit shall be supplied with a two position indicator switch linked directly to the damper to provide the capability of remotely indicating damper blade position.

14 Back draft Dampers

(a) Furnish and install backdraft dampers where indicated on the Drawings. Each damper shall be sized as indicated on the Drawings and shall be suitable for installation in the mounting arrangement shown. Backdraft dampers mounted in roof curbs shall be secured to galvanized steel support angles fastened to the curb.

(b) Pressure relief dampers shall be multi-parallel blade with weighted arm closing assist. The frame shall be anodised aluminium channel sections with formed aluminium blades. Maximum blade length shall be 100 mm, and polyester foam seating strips shall be incorporated on blade edges. Bearing shall be in PVC with non-corrodible shafts.

(c) Backdraft dampers shall be heavy duty relief shutter type suitable for wall and duct mounting or installation at a fan discharge and shall be constructed as follows:

(i) Damper frame shall be constructed of at least 2 mm thick aluminium or at least 1.2 mm galvanized steel. Damper frame shall be of channel construction when installed in ductwork or have a front flange when installed in a wall.

(ii) Damper blades shall be constructed of at least 1 mm extruded
aluminium suitable for face velocities up to 7.5 m/s and at least 1.20 mm extruded aluminium for face velocities to 12.5 m/s. Damper blades shall have neoprene or vinyl gaskets rivetted or rolled into the blade edges. Each backdraft damper section shall be furnished with tie bars constructed of at least 1.2 mm aluminium. Furnish two (2) tie bars on damper sections over 1000 mm wide.

(iii) Damper bearings shall be bronze oilite, nylon, valox, or cycoloy.

(iv) Furnish backdraft dampers with mesh aluminium bird screen for rear mounting where backdraft dampers are mounted in outside walls.

15 Auxiliary Drain Pans

(a) Under any equipment for which a pan is shown on Drawings and under all concealed split unit, VRV indoor units, etc., located above any ceilings or inside electrical rooms and IDF, IT, UPS, Battery Rooms, … etc.

Furnish and install auxiliary drain pans. The auxiliary drain pan shall be at least 200 mm larger in both dimensions than the equipment it is serving and shall be at least 50 mm high.

(i) Drain pans shall be constructed of 2 mm stainless steel with all joints soldered. Pans shall be watertight.

(ii) Drain pans shall have drain pipe connections of at least 25 mm IPS, or as shown on the Drawings. Run 25 mm stainless steel, BS 1837 medium, drain pipe to nearest floor or hub drain independent of any other air handling unit drains, etc.

6.1.3 EXECUTION

1 Installation

(a) The Engineer shall investigate the Contractor sheet metal workshop for approval before starting fabrication.

(b) The installation of ductwork shall be in strict accordance with approved shop drawings, the best practices of the trade and with these specifications. No leaky ductwork shall be accepted.

(c) The interior of all ductwork shall be thoroughly cleaned. All fans shall be operated and debris and foreign matters shall be removed from the ducts.

(d) Hinged access doors shall be furnished and installed in ductwork for required access and for fire dampers volume dampers, smoke dampers, motorized dampers or any concealed equipment inspection as specified herein. Access doors shall be insulated, gasketed, and at least 450 x 450 mm complete with necessary hardware and latches. Install where required walk-in access doors. Wherever necessary, the contractor shall provide suitable access openings to permit inspection, operation and maintenance of all filters, control, dampers,…Etc. Access doors shall be of double skin construction of not less than 20 gauge metal sheet and shall have sponge gaskets around their entire perimeter. On insulated ductwork, the space
between the inner and outer door sheets shall be insulated as specified for ductwork and insulation thickness be equal to duct insulation. All access doors in sheet metal shall be air tight and hinged or lift-off type and secured in the closed position by means of cam latches.

(e) All reached insulated ducts shall be cladded with 0.5 mm galvanized steel sheet.

(f) All insulated and un-insulated duct surfaces in ceiling strips areas shall be externally black painted.

(g) All ducts shall be fitted with openings for temperature and pressure measurements. These openings must be covered with rubber caps, duct supports shall be with rubber pieces and ducts shall be earthed.

### 6.2 AIR DISTRIBUTION EQUIPMENT

#### 6.2.1 General

1 Related Documents

(a) The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

(b) Section 22 of the QCS and these alterations are to be used in conjunction with the preliminaries/General Conditions of the Contract.

(c) Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

2 Scope

(a) Furnish and install all diffusers, ceiling outlets, grilles, registers, sand traps, etc., as required by the Contract and as required for proper air distribution in air conditioned spaces for the various air conditioning systems.

(b) Extent of diffusers, ceiling outlets, grilles, registers, sand traps, exhaust grilles, and registers shall be as indicted on the Drawings.

3 Submittals

(a) Submit the following for approval in accordance with the Conditions of the Contract and Division-1 Specification Sections.

(i) Product Data: Provide air distribution equipment manufacturer’s products data, including printed technical literature, installation instructions and catalogs for each type.

(ii) Schedule of all air distribution equipment including the location, model number, size, capacity performance, noise rating and accessories for each.

(iii) Tests: At the discretion of the Engineer, air outlets may be smoke
tested to determine their compliance with these Specifications. Any revisions required for compliance with terminal velocity requirements, noise level requirements, or maximum temperature variation requirements shall be made at no cost to the Owner.

6.2.2 Products

1 General

(a) The air distribution outlets shall be sized as shown on the Drawings to accommodate the air volumes and throws indicated so as to maintain a terminal velocity of 0.25 m/s in the occupied areas. The overall noise level shall not exceed NC 40. The conditioned air shall be distributed in such a manner that the space temperature shall not vary more than 0.5°C over the entire conditioned area, which shall be defined as the area at the floor to 1.8 m above the floor inclusive. It shall be the responsibility of the bidder to size the air outlets to suit the volume and throw indicated on the Drawings so as to maintain a maximum terminal velocity specified herein in the occupied area and to fit the physical limitations imposed by the structure and surrounding interference. If the bidder cannot comply with the above requirements by following the arrangement shown on the Drawings, he shall notify the Engineer eight days prior to the bid date, in writing, setting forth requested modifications.

(b) The contractor shall furnish factory-calibrated funnel type meter tubes for use in air balancing and distribution equipment. Upon completion of the project the funnel tubes shall be delivered on the Employer.

2 Grilles, Diffusers and Louvres

(a) All grilles, diffusers and louvers shall be similar or approved equal to the types indicated on the Drawings and specified herein. Color to be as required by the engineer and shall be approved prior to delivery to site.

(b) Supply Grille: Supply grille shall be made of extruded aluminium with natural anodized finish with individual adjustable front horizontal profiled blades set at 20 mm. Distance shall be less than the blade length by 0.5 mm and a set of rear individually adjustable vertical air pattern blades. Grilles shall be supplied with opposed blade dampers adjustable from the front face. Dampers shall be made of formed sheet steel with stove enameled black finish.

(c) Return Grilles: Return air grille made of extruded natural anodized aluminium with horizontal 40° fixed angled front blade 20 mm, centers, complete with gasket. Grilles shall have key operated opposed blades damper adjustable from the front face and made of aluminium blades.

(d) Ceiling Grilles: Ceiling grilles shall be made of extruded natural anodized non-vision curved aluminium blades for ceiling mounting and have 30 mm border.

(e) Extract / Exhaust Register: Exhaust Register shall be made of extruded aluminium with natural anodized finish with individual adjustable front
horizontal profiled blades set at 20 mm. Distance shall be less than the blade length by 0.5 mm and a set of rear individually adjustable vertical air pattern blades. Grilles shall be supplied with opposed blade dampers adjustable from the front face. Dampers shall be made of formed sheet steel with stove enamelled black finish, Extract / Exhaust Register shall complete with opposed blade damper adjustable from diffuser face.

(f) Ceiling Diffusers: Square natural anodized colour made of extended aluminium having curved fixed blades on front face gasket and opposed blade damper adjustable from diffuser face. Sizes indicated on Drawings are the neck sizes.

(g) Door Louvers: As type C.G., but with "V" blades and matching rear frame.

(h) External Louvers: External louvers shall be made of extruded natural anodized aluminium section with 80 mm centers. Louver must be weather resistant and have a rear side wire mesh.

(i) Sand Trap Louvers: Sand trap louvers made of extruded aluminium must have wire mesh on the rear side. Trap louvers must be of the self-emptying type and have an efficiency of 80% on 20-200 microns test dust distribution and 50% on 10-70 microns test dust distribution.

(j) Fresh air intake: Fresh air intake louver/grill with anti-vermin screens, sand trap louvers, washable metallic filter and damper. Filter shall be 50mm thick having filtration efficiency not less than 80% average, Air inlet shall be positioned at least 1.2m above ground level. Gooseneck connection shall be provided to prevent ingress of rainwater. The fresh/re-circulating air proportions shall be fixed and the damper pins locked in their respective positions.

(k) Pressure Relieve Dampers (Automatic Shutters): All exhaust air from the building must pass through pressure relieve dampers (automatic shutters) made of extruded aluminium blades and fitted with plastic form seals.

(l) Slot Diffusers: Slots shall be adjustable with flat face, suitable for installation in false ceiling systems.

(i) Slots shall comprise a face section with 1-6 slots, air control blades, which can be adjusted on site to provide either horizontal or vertical discharge.

(ii) Slots diffuser shall be complete with Plenum boxes, volume control damper adjustable from the diffuser face, integral airflow straightener and hit and miss damper adjustable from the diffuser face.

(iii) Extract slots shall be without air control blades.

(iv) Slot diffusers to be with end caps, Plenum boxes supplied loose with bridge snap-in fastening.

(v) Linear lengths of slot diffusers shall be complete with top aligning plates, border alignment pins and slot and plenum hanging brackets.

(vi) Plenum boxes shall be galvanized steel with internal acoustic lining.

(vii) Slots shall be of extruded aluminum sections with powder coating.
(b) Face section material shall be sheet steel with electrostatic powder coating, color shall be approved by the interior specialist, painting thickness shall be 100 um at least, galvanized steel threaded spindle and luck nut.

6.2.3 Execution

2 Installation

(a) Refer to reflected ceiling plans for exact location of air distribution equipment.

(b) Provide all accessories and sub-frames for outlets and inlets required for proper installation.
7. THERMAL INSULATION

7.1 GENERAL

7.1.1 Related Documents

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

4 Scope

(a) Furnish and install thermal insulation as required by the Contract and as herein specified.

(b) Extent of thermal insulation shall be as shown on Drawings.

5 Reference Standards

(a) All insulation and accessories shall be performed in strict accordance with the provisions of the American Society for Testing and Material specifications or other equivalent standards:


(ii) ANSI 331.1 Pipe work Design.

(iii) BS 476 Fire tests on building materials and structures.

(iv) BS 4735 Laboratory method of test.

(v) DW 144 Ductwork installation.

6 Submittals

(a) Submit the following in accordance with the Conditions of the Contract and Division-1 Specification Sections.

(i) Shop Drawings including details, cross-sections, size and method of attachment.

(ii) Product Data: Manufacturer printed data, catalog clippings, test data and recommendations.

(iii) Submit certification and data necessary to show compliance with the...
specification and other governing regulations. These shall include proof of compliance for test of products for fire rating, corrosive resistance and compressive strength.

(iv) Samples: Provide samples of all thermal insulation of same thickness and material indicated for final work and other accessories sets, showing the full range of variation as requested by Engineer. All samples shall be retained on site after approval.

(v) Installation Instructions: Provide a complete set of information concerning the installation of thermal insulation and indicate coordination with requirements of other works.

7.2 PRODUCT

7.2.1 General

1 All insulation and accessories shall have fire and smoke hazard rating as tested by procedure ASTM E84, NFPA 225, and UL 725 not exceeding:

   (a) Flame Spread 25
   (b) Smoke Developed 50

2 All insulation finishes and coverings shall be classified as Class 1 surface spread when tested in accordance with BS 476, Part 7.

3 All adhesive, mastics, coatings, sealers and primers shall be classified as Class 1 surface spread when tested in accordance with BS 476, Part 7. They shall not in any way attack the insulation or the surface to which the insulation is being applied and shall be suitable for the working temperatures.

4 All material delivered to site shall be new and fully dried out and so maintained throughout the progress of the works. All insulating materials shall be stored in storage sheds, and in accordance with the manufacturer's recommendations.

5 Any rough, irregular and badly finished surfaces shall be stripped down and re-insulated to the Engineer's satisfaction.

6 All thermal insulation shall be non-corrosive to the metal, water repellent and fire retardant.

7 All metal surfaces shall be thoroughly cleaned and treated with approved corrosion inhibitor before applying the insulation. Insulation can be applied directly to galvanized surfaces.

8 Lead bearing inserts shall be provided at all supports to ensure that the insulation is not compressed or damaged. The inserts shall be treated hardwood or approved plastic.

9 The vapour barrier shall be continuous and not punctured at any point.
10 The cotton canvas/fibre glass cloth shall be soaked in a compound as approved by the Engineer and shall be overlapped at least 50 mm at transverse and longitudinal cloth joints.

11 Vapour seal materials shall be fire resistant, non-toxic, weather resistant, and anti-fungus quality. Bitumen based products shall not be used.

12 All access doors in ductwork shall be insulated to match the ductwork that they are installed in. The insulation shall be furnished to allow access without damage to the insulation.

13 Cartons shall bear labels indicating that flame and smoke ratings do not exceed above requirements.

14 Insulation pipe hanger shields shall be installed at hangers for insulated piping. At point of support, pipe shall be protected by 360° insert of high density, bearing pressure of 690 kPa, waterproofed calcium silicate, encased in a 360° sheet metal shield. Insert shall be of same thickness adjoining pipe insulation. Shield length and minimum sheet metal gauge shall conform to the following schedule:

<table>
<thead>
<tr>
<th>PIPE SIZE mm</th>
<th>SHIELD LENGTH mm</th>
<th>MINIMUM THICKNESS mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-40</td>
<td>100</td>
<td>0.63</td>
</tr>
<tr>
<td>50-150</td>
<td>150</td>
<td>2.10</td>
</tr>
<tr>
<td>200-250</td>
<td>220</td>
<td>1.80</td>
</tr>
<tr>
<td>300-450</td>
<td>300</td>
<td>1.80</td>
</tr>
<tr>
<td>500 and up</td>
<td>450</td>
<td>1.80</td>
</tr>
</tbody>
</table>

15 Insulation insert to extend 25 mm beyond sheet metal shield on all insulated lines. Pipe hanger shields be thermal hanger shields, model types shall be standard catalog items for specific application. Shields shall be installed in full accordance with manufacturer’s recommendations.

16 Insulation on indoor work shall have composite insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation.

17 Accessories such as adhesives, mastic, coatings, cement tapes and asbestos cloth for fittings shall be applied in strict accordance with manufacturer’s instructions including recommended coverages. Treatment of jackets or facings to impart flame and smoke safety shall be permanent. The use of water soluble treatments is prohibited.

18 The only exception to the above material requirements is where a material meeting these requirements is not available from any manufacturer, in which case substitute items shall be subject to individual approval.

19 Where insulation is specified for piping, insulate similarly all connections, vents, drains and any piping connected to system subject to heat loss or gain.
20 Adhesives and coatings shall be applied according to the manufacturer’s standard insulation instructions. No adhesives or cements shall be applied to ambient temperatures below those recommended by manufacturers.

21 All pipe sleeves and duct openings penetrating floor slabs, partitions, walls, etc., shall be packed with fiberglass and sealed with mineral wool (with a fire retardant adhesive).

7.2.2 Piping Insulation Types

1 Insulation Thickness and Type of Application

2 Piping system described shall be insulated as follows, including all flanges, fittings, valves, expansion joints, vents, drains and all other parts of the system.

<table>
<thead>
<tr>
<th>Piping System</th>
<th>Insulation Thickness</th>
<th>Insulation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain and copper pipes.</td>
<td>50 mm : 10 mm</td>
<td>P-1</td>
</tr>
</tbody>
</table>

3 Type P-1 Fiberglass Insulation and Foam Rubber for Drain and copper pipes.

(a) The pipe covering and insulation shall be manufactured by a recognised manufacturer and shall be neatly installed to the following:

(i) The general intent is to provide a sealed insulation which will not permit sweating of the pipes and which will not retain moisture to the detriment of its insulating capability.

(ii) The refrigerant suction lines only shall be insulated with 19 mm thick foam rubber having a thermal conductivity factor of 0.036 W/m2/K and a maximum water permeability of 0.09 μgm/NH. Alternatively, the pipes shall be insulated with 50 mm thick rigid fiberglass insulation and vapour sealed in the same manner as chilled water pipes, care shall be taken to ensure the integrity of vapour sealing is not damaged in any way.

(iii) The material shall be supplied as pre-formed pipe sections in tubular or pre slit form.

(iv) The insulation shall be installed accordingly to the manufacturer’s recommendations using a non-flammable adhesive.

(v) All exposed insulation shall be given two coats of chlorosulphonated polyethylene paint.

(vi) All condensate drains within plant rooms or other internal areas subject to damage or sweating shall be insulated using 25 mm thick rigid fibreglass or 10 mm thick foam rubber insulation. The insulation shall be vapour sealed as for chilled water pipes; care shall be taken to ensure the integrity of vapour sealing is not damaged in any way.

7.2.3 Duct Insulation Type

1 Insulation for Sheet Metal: Note that ductwork and casing which are acoustically
lined, as described elsewhere, need to be insulated on the exterior surface with insulation such that the overall insulation internally and externally satiasfy the specification as called for below.

2 Insulate sheet metal as follows:

<table>
<thead>
<tr>
<th>Duct system</th>
<th>Insulation Thickness</th>
<th>Insulation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible duct connection</td>
<td>25 mm</td>
<td>D-1</td>
</tr>
<tr>
<td>Ducts in equipment rooms</td>
<td>50 mm</td>
<td>D-2</td>
</tr>
<tr>
<td>Ducts outside air-conditioned spaces inside and outside the building and Risers.</td>
<td>50 mm</td>
<td>D-2</td>
</tr>
<tr>
<td>Ducts in false ceiling of air-conditioned spaces</td>
<td>25 mm</td>
<td>D-2</td>
</tr>
</tbody>
</table>

3 Type D-1 Flexible Duct Insulation with Vapour Barrier:

(a) Flexible duct insulation shall be fiber glass with a density 24 kg/m³ density and a thermal conductivity of not more than 0.037 W/m²/°, flame resistant, flexible fiberglass insulation. Overlap onto adjacent insulation and seal with adhesive duct tape to give good closure.

4 Type D-2 Rigid Duct Insulation with Vapour Barrier:

(a) Rigid supply and return duct insulation shall be fiber glass with a density 48 kg/m³, a maximum K factor thermal conductivity factor of 0.037 W/m²/K at 24 °C with factory applied barrier jacket, the aluminium foil faced fiberglass duct insulation and fastened with adhesive of high quality.

(b) An approved adhesive material shall be applied on the entire surface of duct-wall and entire surface of insulation. In addition, adhesive shall also be applied on insulation butt and lap joints. The adhesive applied to the insulation shall cover evenly the faces to be fixed, the surfaces forming the longitudinal joint and the surfaces forming the circumferential joint. Upon the application of the approved adhesive, the insulation shall be fixed in position immediately and permanently.

(c) Adhesive tape, not less than 75 mm wide, shall be used to seal both the circumferential and longitudinal joints. Suitable GI angle edges shall be applied on the four corners of square and rectangular ducts as an additional protection.

(d) Cover and secure 200 g/sq. meter high quality canvas cloth while it is wet (soaked in approved vapor sealant) and then wrap carefully to become a vapor seal with a smooth surface free from wrinkling and gaps. Ensure that the overlap shall be 50 mm minimum. After it is dry, apply further brush coats of vapor seal to the Engineer's satisfaction. The vapor seal material shall be fire-resistant, non-toxic, weather resistant and of anti-fungus quality.
(e) Alternatively, the Contractor may propose self-adhesive type cross linked polyethylene insulation of minimum 15mm thickness complete with factory applied aluminium foil. Contractor shall be obliged to obtain engineer's approval before ordering any alternative materials.

(f) Bitumen based products shall not be used.

(g) For insulating the underside of the internal and external ducts whose longest side is more than 600 mm, apply plastic hangers and washers riveted to the duct as additional supports. Hangers shall be provided at 300 mm centers.

7.2.4 Acoustic Lining

1 Acoustic lining shall be provided when specified in the Project Documentation.

2 The lining shall be glass fibre or mineral wool slab and faced to minimise fragmentation and fibre fly. The type and thickness of the lining shall be approved by the Engineer.

3 The ductwork shall be size to allow for the thickness of the lining.

4 The ductwork surfaces must be thoroughly cleaned and the lining fixed by an approved adhesive over the whole area to be lined.

5 Mechanical fasteners must be used at 400 mm maximum centres and not more than 75 mm from joints, corner breaks etc.

6 All edges shall be sealed or enclosed by a light metal section mechanical fastened to the duct.

7 If required by the Engineer, metal mesh may be required as a precaution against displacement or break up.

8 Acoustic lining shall be provided for all air handling units / AC units supply and return ducts to the nearest air outlet(s) from the supply fan discharge / return mixing box.

7.2.5 Insulation for Equipment and Special Systems

1 The following cold equipment shall be insulated with vapour barrier insulation using type E-1 insulation:

<table>
<thead>
<tr>
<th>Piping system</th>
<th>Insulation Thickness</th>
<th>Insulation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaporators</td>
<td>50 mm</td>
<td>E-1</td>
</tr>
<tr>
<td>Single inlet fans (downstream of cooling coils)</td>
<td>50 mm</td>
<td>E-1</td>
</tr>
</tbody>
</table>
2 Type E-1 Glass Fiber Rigid Equipment Insulation with Vapour Barrier:

(a) Insulation shall be 96 kg/m³ density glass fiber with vapour barrier facing and having a maximum K factor of 0.24 at 23°C mean temperature.

(b) Insulation shall be firmly held in place with copper-clad wire or pins and clips on 300 mm centers.

(c) All joints and voids in the insulation shall be filled with mineral wool cement. All joints and breaks in the vapour barrier shall be sealed with strips of the vapour barrier facing adhered with vapour barrier adhesive.

(d) Finish shall consist of embedding an open weave glass fabric (500 x 500 mm) into wet coating of lagging adhesive overlapping the seams at least 50 mm. A finish coat of lagging adhesive shall be applied.

(e) Sections of equipment requiring periodic servicing such as heads and pumps shall be insulated with sheet metal covers lines with 67 kg/m³ density fiberglass board.

(f) Aluminium Access Covers:

(i) Sections of equipment requiring periodic servicing shall be insulated with aluminium covers lines with the same thickness of material as the adjoining insulation.

3 Apparatus Casings:

(a) Insulate apparatus casings which are not provided with insulation as follows:

(i) Apply generally 50 mm of rigid polyurethane insulation, 24 kg/m³ density. On the underside of coil sections, apply 50 mm thick polyurethane insulation, 24 kg/m³ density. All joints are to be sealed in cold adhesive compound.

(b) Ensure that any access panels are insulated to the same standard and are openable.

(c) For small units, cover the entire outside assembly with waterproof self adhesive glass fibre tape. This must be at least 75 mm minimum width and must overlap at least 50 % on each application, to achieve watertight conditions.

(d) For larger units, provide a weather resistant enclosure outside the insulation, subject to Engineer’s approval.

(e) Ensure that all equipment meets these requirements, regardless of manufacturer’s standard practice, and add insulation as required to the above standard.

(f) Where insulation, re-installation or additional insulation is required to the casing of externally mounted air conditioning units, the insulation shall be covered with sheet Aluminium, of 0.9 mm or thicker.

(g) Insulation of drain pans is specified for AHU and FCU regardless of the manufacturer’s standard supply, the contractor shall re-insulate on site if
necessary so that the specification is complied with in full.

7.3 EXECUTION

7.3.1 Installation

1 No insulation shall be applied until the surfaces of equipment to be insulated are thoroughly cleaned and until pipes and equipment to be insulated have been tested and proven tight and accepted by the Engineer. Any leaking pipes or equipment shall be brought to the attention of the contractor who shall cause these conditions to be corrected. All surfaces shall be thoroughly dry before application of any insulation.

2 The execution of the insulation work shall be in strict accordance with the best practices of the trade and with the specifications herein.

3 The insulation shall be handled and applied in a manner that shall not adversely affect its structural or insulating properties.

4 The installation of insulation and accessories shall be in accordance with approved installation drawings and manufacturer's recommendations.

5 Insulation shall be continuous through wall and ceiling openings and sleeves.
8. EXHAUST AND VENTILATING FANS

8.1 GENERAL

8.1.1 Related Documents

1. The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2. Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3. Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

8.1.2 Scope

1. Furnish and install exhaust and ventilating fans as required by the Contract and as specified herein.

2. Extent of exhaust and ventilating fans is indicated on Drawings.

8.1.3 Reference Standards

1. All exhaust and ventilating fans shall be designed, manufactured and installed in accordance with "Engineering Standards of Multiple V-Belt Drives 1982" as adopted by the Mechanical Power Transmission Association, and the Rubber Manufacturer Association, Inc.

2. All units installed outside the building shall be supplied with factory installed weatherproof shading.

8.1.4 Submittals

1. Submit the following for approval in accordance with the Conditions of the Contract, and Division-1 Specification Sections.

   (a) Product Data: Provide fans manufacturer's performance data such as printed data, catalogue, Certified fan performance curves and certified static and dynamic balancing test.

   (b) Shop Drawings: Provide certified drawings showing overall dimensions, weight, fan horsepower, size, type, details and installation requirements.

   (c) Installation instructions, operating and maintenance manual.

   (d) Tests: Fans shall be tested and rated in accordance with AMCA standards and provide AMCA Certified Ratings Seal.
8.2 PRODUCTS

8.2.1 General

1. Fans shall be of the types and capacities as indicated on Drawings. Fan drives shall be selected with a minimum belt rating.

2. The whole fan assembly shall be fully finished against corrosion.

3. Access shall be provided to carry out all necessary maintenance required.

4. The electrical terminal box shall be located to allow for easy connection and disconnection the electrical supply.

5. Each motor for a belt-driven fan shall be mounted on an adjustable base rigidly supported on the fan and shall have an extended shaft to accommodate the adjustable pitch sheaves.

6. Each fan shall be provided with vibration isolators as specified in Section entitled "Vibration Isolation".

7. Each fan shall be given a bonding coat before painting. All parts shall be spray painted with two (2) coats of gray primer finisher before and after assembly. Exterior surface shall have enamel finish.

8. The noise ratings for each fan shall not exceed the levels specified in the QGEWC regulations for the area being served.

9. All fans used for life safety operations or hazardous operations shall be subject to Civil Defence Department approval.

10. All extract fans shall be provided with an electrical isolator adjacent to the unit.

11. All fans shall be capable of operating at ambient temperatures of 55°C and the casing material shall be able to withstand sun radiation temperature up to 85°C.

12. All fans shall be provided with an electrical isolator adjacent to the unit.

13. All motors are to be positioned to permit effective ventilation of the motor and all components of the fan and motor are to be suitable to withstand the temperature conditions expected.

14. All fans shall be installed to avoid vibration and noise to the ductwork or building fabric.

15. Where fans are fitted with noise attenuators, full details of the attenuators shall be submitted for approved by the Engineer.

8.2.2 Cabinet Type Fans

1. Each cabinet type fan shall be complete with housing, fan, adjustable V-belt
drive, motor, etc. Applicable portions of the specifications for factory-built air handling units apply as if herein repeated in full except that a cabinet type fan shall be without a drain pan and the casing shall be single skin.

2 The casing of cabinet type exhaust fan shall be made of heavy gauge galvanize steel sheet and finished with epoxy backed powder paint, resulting excellent corrosive resistance which ensure long life of equipment.

3 The exhaust fans shall be provided with low leakage gravity louvers.

8.2.3 Roof Mounted Type Fans

1 The roof exhaust fan shall be supplied with direct driven down blast complete with casing, fan wheel, motor, mounting base frame, vibration isolators, bird screen, shutter and curb.

2 The roof supply fan shall be supplied with direct driven down blast complete with casing, fan wheel, motor, mounting base frame, vibration isolators, bird screen, shutter, washable filter and curb.

3 The fan shall be housed in a base fitted with a weathering skirt and covered by a cowl with curved contour.

4 The fan construction shall be weatherproof, heavy gauge steel, all-welded and hot-dip galvanized. All fan parts shall be protected against corrosion.

5 The fan wheel shall be forward inclined centrifugal or backward type as per design requirements; all welded construction shall have blades of not less than 2.75 mm galvanized steel. The entire motor drive assembly and fan wheel as a unit shall be removed through the support structure without dismantling the fan housing.

6 For hot air extraction (kitchen exhaust) the fan motor, the drive and bearings shall be isolated from the air handled by the fan.

7 The fan motors are of totally enclosed squirrel-cage induction design, with Class F insulation, suitable for ambient temperatures up to 55°C.

8 Provide factory wired non fusible type disconnect switch at motor in fan housing, thermal overload protection in fan motor and conduit chase within unit for electrical connection.

9 The motors can be positioned for lubricating from above the roof. Hinged curbs giving access to the lubricators.

10 The extract units must be fitted with automatic shutters with removable bird screen installed within the curb, opened by the fan draught and closed when the fan stops.

11 Bird screen less than 25 mm mesh shall be provided as an integral part of the
The curbs shall be insulated metal suitable to fit base of roof and to suit roof construction and colour.

8.2.4 Centrifugal Type Fans

Centrifugal type fans shall be single width, single inlet and have arrangements as indicated on Drawings.

The centrifugal extract fans shall be of the non-overloading type.

The fan impeller shall have ample strength and shall be statically and dynamically balanced to avoid vibration.

All fans scheduled to be located outdoors shall be furnished with weather proof motor and drive housings.

Fans shall be factory-assembled and tested consisting of housing, wheel, fan shaft, bearings, and side support structure.

Housings shall be galvanized steel with lock seam construction for sizes 600 mm to 1000 mm, spot welded construction for sizes 1100 mm to 1500 mm and continuous weld construction horizontal splits, bolted together for sizes 1650 mm and larger, beaded discharge reinforcement. Housings shall be of the adjustable type with continuous spun inlet cones with duct connections collars.

Wheels blades shall be backward inclined plate-type for sizes 560 mm and smaller, non-power overloading backward inclined airofoil blades for sizes 600 mm and larger blades made of die cut and die formed shall be welded to steel wheel rim and hub plate, wheels to be keyed to shafts. Shafts shall be constructed of AISI C 1040 or 1045 solid hot-rolled steel, turned and polished.

Bearings shall be heavy-duty, grease-lubricated, precision anti-friction ball or roller, self-aligning, pillow block type bearings selected for minimum average life (AFBMA L 50) of 100,000 hours. Fan bearings and drive are to be enclosed and isolated from air stream.

Drive shall be V-belt drive, selected for 1.4 service factor with adjustable pitch sheaves, selected for midpoint at design conditions.

Fan shall be capable to operate satisfactorily with 55°C outside air temperature.

Fans used for smoke shall be rated to work at 300°C for 2 hours and their motors shall be IP55 and Class E insulation or as per design requirements.

The fan motor shall be sized to drive its respective fan when the fan is operating at a speed 10% in excess of that required to meet the fan performance. No motor shall operate within the service factor.
8.2.5 Axial Fans

1 Provide factory-fabricated and tested axial wall mounted or inline fans. Fan units consisting of fan blades, hub, housing, orifice ring, motor and drive.

2 Fan shall have heavy gauge galvanized steel construction housing with flanged edge and integral orifice ring. The fan blades shall be of airfoil welded galvanized steel construction with spun steel spider bolted to cast-iron hub. All fan parts shall be protected against corrosion. Fan and motor bearings shall be sealed and of self lubricating type.

3 Fan shall be direct driven with totally enclosed single speed motor having flange-type bearings, and standard NEMA frame size.

4 Fan shall be capable of operating satisfactory with 55°C outside air temperature and 100% relative humidity.

5 Fans used for smoke evacuation applications shall be variable speed type and fire rated at 300°C for 2 hours or as specified in the design documents.

6 Each fan shall have heavy gauge gravity shutter blades in the discharge side (if no external louvers installed) and galvanized steel wire guard in the motor side. The shutter operation shall be tested before delivery to site insuring no rattle sound shall be recognized.

8.2.6 Kitchen and Smoke Extract Fans

1 Kitchen extract fans shall be suitable for use in the kitchen exhaust system for a combustible grease laden air stream. The exhaust fan shall be of aluminum construction, upblast type. The impeller shall be of backward curved centrifugal type, statically and dynamically balanced of aluminum construction.

2 The fan motor and drive components shall be out of the air stream and protected by a weather proof cover. The fan shall be provided with accessible weather proof electrical isolator (disconnect switch). The fan drive assembly shall be provided with an adjustable pitch pulley to adjust the fan speed for air balancing the exhaust air quantity. The fan shall be provided with a drain connection for drainage of grease, water, or other residue and a grease trap of aluminum construction to collect grease residue, avoiding drainage onto roof surface.

3 The selection of the exhaust fans shall be made using a safety factor of +20% for the calculated maximum fan static air pressure requirement and +15% for the design fan exhaust air volume flow rate.

4 The fans shall be suitable for removal of smoke and grease laden vapours and shall be rated for continuous operation 300 °C.

5 Smoke and Kitchen extract fans shall be UL Listed, FM Approved, QCDD Approved and shall comply to UL 762, UL 705 and NFPA 96.
Smoke and Kitchen fans should be rated smoke and should be rated for Two hours at minimum smoke temperature of 300°C or as specified in the design documents.

8.2.7 Protectively Coated Extract Fans for Corrosive or Hazardous Use

1. Where the fans are required to handle corrosive toxic flammable explosive or high temperature gases the materials and construction shall be required to suit the application and all relevant safety regulations shall apply.

2. Bearing and lubrication arrangements shall be suitable for the conditions expected.

3. Where protective coating is required to use with corrosive gases the coating shall cover all parts of the complete fan, motor and casing assembly which will be in contact with the corrosive gases.

4. All fans shall be subject to Civil Defence Department approval.

5. The fan motors for hazardous use or required to handle flammable or explosive gases shall be flame proof.

6. No fan shall be installed if the protective coating has been damaged in any way.

7. Extract fans (duty/stand-by) used for Battery Room shall be non-sparking design and the motors shall be bifurcated and explosion proof suitable for Zone 1, ATEX rated Eex-de and Gas Group IIC (Battery room applications).

8.2.8 Wall and Window Mounted Extract Fans

1. Extract fan shall be of the propeller type suitable for wall/window mounting.

2. The fan construction shall be of moulded plastic

3. Motors shall be of the shaded pole induction type enclosed in an aluminium alloy case and protected by a thermal over load cut out.

4. The motor bearings shall be self alignment sealed for life type.

5. The fans shall be provided with a solenoid operated back draught shutters. The solenoid shall open and close the back draught damper silently as the fan is switched ON and OFF.

8.2.9 Propeller Type Extract Fans

1. The impeller shall be of steel or aluminium and the blades shall be fixed to the hub or the blades and hub shall be formed in one piece.

2. The bearings shall be ball, roller or sleeve type sealed for life or with accessible lubrication points.
3. The casing shall be longer than the length of the motor and fan.

4. The casing shall be of steel construction with flanged ends and shall incorporate an inspection door.

5. The terminal box shall be mounted externally on the casing.

6. The tip speed of the fans shall not exceed 20 m/s.

7. Inlet and outlet grilles shall be installed on the fans incorporating gravity back draught damper.

**8.2.10 In-Line Extract Fans**

1. In-Line extract fans shall be centrifugal, axial or mixed flow type fans as detailed in Project Documentation.

2. The construction and installation shall be as specified.

3. The casing shall be rigidly constructed of mild steel or aluminum alloy and shall be stiffened and braced to obviate drumming and vibration.

4. Mounting feet shall be provided for bottling to a base or supports.

5. The inlet and outlet shall terminate with flanges to facilitate installation and removal.

6. Access panels shall be provided and shall be sized to facilitate maintenance.

**8.2.11 THRUST (JET) FANS**

1. **AXIAL JET FANS**

   (a) All jet fans used for life safety operations or hazardous operations shall be subject to Civil Defense Department approval.

   (b) The jet fans casing consist of a 3 mm rolled steel tube, circular fan tube with oval flanges an oval silencer is mounted on each flange.

   (c) Description: Factory-fabricated, -assembled, -tested, and -finished, direct driven axial fans consisting of housing, impeller, aluminum alloy blades, bearings, motor, drive assembly, Extended Lubrication Lines, attenuators/silencers on supply and intake and support structure. Jet fans range comprises 50N, suitable for ambient temperature operation plus 300°C for two hours high temperature smoke conditions.

   (d) The impeller consists of a hub discs with cavities in which four blades are mounted in preset positions

   (e) The fans shall be delivered with hot galvanized 3mm steel sheet suspension brackets for direct mounting to ceiling.

   (f) Casing: Metal fan casing provides a robust construction, assisted by the
long lasting paint finish. The integral mounting flanges on the casing allow the unit to be mounted easily to the structure. Casing parts are manufactured from heavy gauge mild steel sheet powder coated.

(g) Impeller: forward impellers, high aerodynamic efficiency, mild steel, impeller assemblies are dynamically balanced to grade G6.3.

(h) Shaft: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower.

(i) Pre-lubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.

(i) Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.

(j) Grease-Lubricated Shaft Bearings (if applied): Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

(ii) Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.

(iii) Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.

(k) Motors: Comply with Qatar Civil Defense specifications / regulations*

(i) Enclosure Type: Totally enclosed, fan cooled.

(ii) Two speed motor.

(iii) IP 65 lockable fire rated isolator in accordance with IEC34-5, class H.

(iv) Operation 300°C for two hours during smoke conditions.

(v) Capacities and Characteristics: As per contract documents and design requirements.

(l) Axial fans shall be complete with Factory-fabricated, -assembled, -tested, and -finished silencers to reduce noise level to 50 dBA at low speed, silencers contraction shall be galvanized sheet steel, Outside sheet for fan housing and silencer: 0.75 mm sheet in alu-zinc, In side tube for silencer: shall be perforated pre-galvanized sheet steel and include two inches of sound absorbing fiberglass is sandwiched between the inner and outer shell. The fiberglass shall be moisture resistance, fire proof meets requirements of NFPA 90A and 90B, and ASTM C 1071 Type I. The liner meets all requirements for 25 flame spread or 50 smoke development when tested in accordance with ASTM-E84, UL-723 and NFPA-255.

(m) The silencer and fans shall be complete with Factory-fabricated, -assembled stainless steel wire guard is mounted on the inlet side and aluminum deflector is mounted in the outlet side. the deflector deflect the air in the desired direction

2 Source Quality Control

(a) Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
(b) Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

8.3 EXECUTION

8.3.1 Installation

1. Install fans in accordance with manufacturer's instructions and with recognized industry practices to ensure that fans comply with requirements and serve intended purposes.
2. Provide enough access and service space around and over fans as recommended by manufacturer.
3. Provide 100 mm high concrete pad under floor-mounted fans.
4. Set fans on vibration isolators; fasten in accordance with manufacturer's installation instructions.
5. Provide flexible connections on inlet duct connections.
6. Install thrust fans level and plumb.
7. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 25 mm. Vibration-control devices
8. Install units with clearances for service and maintenance.

8.3.2 Tests

1. Start-up, test, and adjust fans in presence of manufacturer's authorized representative.
2. All fans shall be earthed.
3. Where damage is caused to any other item by any failure of the item warranted then the warranty shall also include the costs incurred in rectifying the damage.

8.3.3 Field Quality Control

1. Perform the following field tests and inspections and prepare test reports:
   (a) Verify that shipping, blocking, and bracing are removed.
   (b) Verify that unit is secure on mountings and supporting devices and that connection to electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   (c) Verify that cleaning and adjusting are complete.
(d) Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.

(e) Adjust damper linkages for proper damper operation.

(f) Verify lubrication for bearings and other moving parts.

(g) Remove and replace malfunctioning units and retest as specified above.

2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
9. ACOUSTIC TREATMENT

9.1 GENERAL

9.1.1 Related Documents

1. The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2. Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3. Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

9.1.2 Scope

1. Furnish and install acoustic treatment sections as required by the Contract and as herein specified and as required to satisfy the sound levels specified.

2. Extent of acoustical treatment works is shown on Drawings.

9.1.3 Reference Standards

1. Acoustic treatment shall be performed in strict accordance with requirements of applicable local codes, ASHRAE and NFPA, Standard Specifications or other equivalent International Standards and Sound Practice.

9.1.4 Submittals

1. Submit the following for approval in accordance with the Contract, and Volume 1 Section B conditions of contract.

2. Product Data: Provide manufacturer's data sheets such as printed data, catalog and erection and installation instructions.

3. Test Reports: Provide factory performance data and field tests as requested by Engineer.


9.2 PRODUCTS

1. Acoustic treatment system shall be done by sound linings or sound attenuators or combination of them.
9.2.2 Acoustical Performance Specification

1 It is the intent of this specification that noise levels due to air-conditioning and/or ventilating equipment, ducts, fan coil, units, grilles, registers and diffusers shall permit attaining sound pressure levels in occupied spaces conforming to the following NC criteria as explained in the latest issues of the ASHRAE Guide and Data Book. All spaces shall not exceed the noise criteria specified below:

<table>
<thead>
<tr>
<th></th>
<th>DbA</th>
<th>NC Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generally</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Clinic's</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Atrium</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Multi-purpose hall</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Cafeteria</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Library</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Swimming pool</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>Lounge &amp; corridor</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Office</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Prayer Area</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Toilet &amp; Pantry</td>
<td>40</td>
<td>35</td>
</tr>
</tbody>
</table>

9.2.3 VAV boxes

1 The maximum permissible sound power levels in octave bands for VAV boxes run at medium speed shall be as follows:

<table>
<thead>
<tr>
<th>OCTAVE BAND</th>
<th>MAXIMUM PWL re 10-12 WATTS (NC-35)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>56</td>
</tr>
<tr>
<td>3</td>
<td>49</td>
</tr>
<tr>
<td>4</td>
<td>46</td>
</tr>
<tr>
<td>5</td>
<td>43</td>
</tr>
<tr>
<td>6</td>
<td>42</td>
</tr>
<tr>
<td>7</td>
<td>41</td>
</tr>
<tr>
<td>8</td>
<td>40</td>
</tr>
</tbody>
</table>

2 The VAV boxes manufacturer shall submit to the Engineer guaranteed sound power levels by octave bands. Sound power level data submitted shall
substantiate that the equipment types and sizes operating in an installed condition as per Drawings and specifications and shall conform with these requirements.

3 Tests: The VAV boxes shall be tested in accordance with ASHRAE Standard 36B-36 with ratings tabulated for medium speed operation.

4 Should the Employer desire that units be checked for conformance to the above acoustical performance, the cost of such test shall be paid by the Contractor.

9.2.4 Grilles, Registers, Diffusers

1 The maximum permissible sound power levels in octave bands of grilles, registers and diffusers when operated in an installed condition space as per Drawings and specifications, shall be as follows:

9.2.5 Acoustical Performance within Equipment Spaces

1 Equipment room noise levels and noise transmission to adjacent buildings shall comply with all Local Noise Ordinances.

9.3 EXECUTION

9.3.1 Duct Acoustic Treatment

1 Duct Lining: Supply, return and exhaust ductwork shall be installed with acoustical lining where required. Such acoustic lining shall be a minimum of 25 mm thick mat faced duct liner meeting the requirements of NFPA 90-A, and be fiberglass of 25 kg/m3 density. Flame spread: maximum 25, fuel contributed, and smoke developed: maximum 50, suitable for duct velocity of 20 m/sec, dynamic loss coefficient: maximum 1.2, k factor: maximum .036, noise reduction coefficient: for 25 mm thick lining: minimum 0.75.

2 Dimensions of lined ducts are the inside dimensions of the ducts after the lining has been installed. Duct liner shall adhere with 100% coverage of Benjamin-Foster 85-20. Mechanical fasteners which do not pierce the sheet metal shall be on 400 mm centers on top sections (when width exceeds 300 mm) and on sides (when height exceeds 600 mm). All butting edges of acoustic linings shall be folded under and stapled to ensure that all raw edges are sealed and all exposed edges of acoustic linings shall be installed with sheet metal nosing. An inner liner need not to be provided to cover acoustic insulation except where duct velocity exceeds 12.5 m/sec. Ductwork shall be provided with galvanized metal.

3 The following ductwork shall be acoustically lined as a minimum requirement:

a) All supply, return AHU’S rectangular ductwork (except kitchen) which in roof. If the distance from unit discharge to shaft inlet is less than 4 m minimum, continue acoustical lining to a distance of 6 m from fan inlet and discharge.
b) Supply and Return air fan, AHU plenum lining shall be 50 mm thick 40 kg/m³ density.

9.3.2 Sound Attenuators

1 Silencers

a) At shop drawing stage, the contractor will undertake calculation for every unit and every area and determine the insertion loss required to meet the stated noise criterion.

b) Supply and return duct noise must be considered as well as duct breakout noise.

c) Materials of construction shall be galvanized sheet metal and mineral fibres acoustic fill which is inorganic, inert, moisture and vermin resistant. Silencers shall be so constructed as to prevent erosion and pregnability of the acoustic fill.

d) The silencers shall incorporate a removable panel which provides complete access to all internal surfaces for cleaning and also permits removal and replacement of acoustic fill.

e) Silencers shall be factory made, and shall have available certified test data concerning insertion loss. This must be available when required, in advance of ordering units. Where a silencers is made under licence, or part assembled locally, then tests must also be made after assembly and witnessed by an independent authority.

f) The static pressure loss of any required silencer must be considered in air handling equipment original selection.

g) Silencers shall be installed in locations as indicated on the contract drawings.

h) Silencers shall be flanged to exactly match the adjacent ductwork in which they are to be installed.

i) All air ductworks shall be attenuated to limit the noise level to the values specified in the design criteria. The method of fabrication and supporting ducts should be such as to avoid generation of noise because of air movement or drumming of sheet metal.

j) The silencers shall be provided in the supply and return air ducts as shown on the tender drawings. The silencers shall be constructed and tested according to BS 4773 Part 1971 and ASHRAE Standard 36 B-63 for dynamic insertion loss; self generated noise and aerodynamic performance.

k) The outer casing of the silencers shall be constructed of 22 gauge galvanized sheet steel. Baffles shall be made of 24 gauge perforated galvanised steel, filled with an odorless, incombustible, vermin and moisture proof inorganic sound absorbing material. The fill shall be compressed 10% and shall be of a density sufficient to meet catalogued performance. The acoustical fill shall have the following minimum ratings
flame spread not over 25, smoke developed not over 20. The silencers construction shall be such that perforated sheet shall cover the black neoprene sheet over the insulation in order to avoid ingress of fibre articles.

l) The silencers shall be complete with flanges to facilitate their removal for inspection. Externally, the silencers shall be insulated in the same manner as the adjoining air ducting. The Contractor shall carry out sound absorption calculations with respect to the characteristics and the duct system to ensure the proper selection of silencers.

m) Take-offs from main ducts shall be conical. All take-offs and connections shall be constructed to minimize pressure loss. All raw edges of ductwork seams, rivets and areas where galvanizing has been destroyed shall be cleaned, prepared and painted with zinc rich paint at works and a further coat shall be applied after erection.

n) Allowances shall be made in ductwork construction for instruments and control connections and adequate local stiffening shall be incorporated to provide rigid mountings.

2 The fabrication of ductwork shall be carried out in accordance with HVAC/DW/144, ASHRAE or SMACNA standards.

3 Sound attenuators media shall satisfy the following:

a) Flame spread: maximum 25.

b) Fuel contributed and smoke developed: maximum 30.

c) Maximum 64 kg/m3 density glass or mineral fiber packed under 5 pierce compression.

d) Filler to be inert, vermin and moisture proof.

e) Internal construction shall be galvanized perforated steel baffles: 0.85 mm.

f) Net insertion loss ratings.

  (i) Determined by duct-to-reverberant room test method at design airflow.

g) Minimum sound trap dynamic insertion loss to be as follows:

<table>
<thead>
<tr>
<th>OCTAVE BAND</th>
<th>TYPE MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>6</td>
<td>34</td>
</tr>
</tbody>
</table>
h) Maximum self-generated noise at 10 m/s face velocity

<table>
<thead>
<tr>
<th>OCTAVE BAND</th>
<th>TYPE MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>54</td>
</tr>
<tr>
<td>3</td>
<td>52</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>44</td>
</tr>
</tbody>
</table>

9.3.3 Certified Tests

1 Submit certified test data from approved laboratory for pressure drop and insertion loss ratings. Certification data for pressure drop and net insertion loss, based on tests of same attenuators. Attenuators and tests subject to inspection upon request of the Engineer.

9.3.4 Installation

1 Install in accordance with manufacturer’s recommendations to obtain published performance.

2 Install in accordance with approved shop drawings.

3 It is the responsibility of the contractor to ensure that the noise emitted from the equipment on the roof will not be transmitted to the occupied areas in the last floor. It will be the contractor responsibility to investigate the extra precautions to be considered regarding sound isolation of equipment installed on the roof from being transmitted to occupied areas in the last floor after the selection of these equipment. The contractor has to submit to the consultant the extra measure that will be followed to ensure proper sound levels in the last occupied floor.

9.3.5 Tests

1 Submit certified test data.
10. UV DISINFECTOR

10.1 GENERAL

10.1.1 Related Documents

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

10.1.2 Scope

1 Furnish and install UV Disinfector as required by the contract and as specified.

10.1.3 Submittals

1 Submit the following for approval in accordance with the Contract, and Volume 1 Section B conditions of contract.

10.2 PRODUCTS

1 The “UV Disinfector”

2 System Description:

(a) The UV system disinfects the effluent by exposing it to a powerful ultraviolet light in a confined space. A flow restrictor ensures that the effluent is exposed to the UV light for a sufficient period of time to complete the disinfection process. A control panel is provided that supplies power to the UV system and has an audible and visible alarm that activates if the bulb fails of the UV current drops below a minimum level. The control panel is housed in a weather proof enclosure and has separate circuit breakers for the UV system and the alarm system.

10.2.2 Specifications:

1 Minimum Recirculation Inactivation Rate should be as the following:

2 Influenza A virus 99.5 %, tuberculosis 99.5 %, smallpox 99.5 %, parvovirus 99.5 %
3 Recirculation Inactivation Rate is calculated after 8 passes. The Inactivation rate increases marginally after 8 passes.

4 Single pass inactivation (sterilization) rates should be as the following:

5 Influenza A virus 75 %, tuberculosis 75 %, smallpox 75 %, parvovirus 75 %.

6 Single Pass Inactivation means that the air is exhausted after it is treated and is not Recirculation.

7 Maximum pressure drop at UV lambs installation point 0.015 in H2O.

8 Maximum air temperature increase due to UV lambs 0.25 °C.

9 Results are as at lamp change out time (17,000 operating hours)

10 The high intensity UVC lamps will be of the low-pressure, mercury laden argon-neon type with an internal Alumina coating to reduce solarization.

11 UV Lamps: Location = should be inside the supply duct.

12 The UV intensity for each individual lamp shall not be less than;

(a) 270 microwatts per/cm2 at 36 inches for the 24 inch lamps,
(b) 290 microwatts per/cm2 at 36 inches for the 30 inch lamps
(c) 500 microwatts per/cm2 at 36 inches for the 40 inch lamps;
(d) 580 microwatts per/cm2 at 36 inches for the 50 inch lamps;
(e) 640 microwatts per/cm2 at 36 inches for the 60 inch lamps.

10.3 EXECUTION

1 UV Lamps shall be installed in accordance with manufacturer installation instructions and Drawings.

2 Provide submittal indicating the location of the UV Lamps.

3 Provide clearances for servicing and maintenance.
11. MOUNTING AND ISOLATING OF MECHANICAL SYSTEMS

11.1 GENERAL

11.1.1 Related Documents

1. The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2. Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3. Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

11.1.2 Scope of Work

1. Furnish and install as required by the Contract, foundations, vibration isolations and associated equipment to eliminate transmission of movement from the rotating equipment, piping, etc., to the structure or connected piping systems as specified herein.

11.1.3 Reference Standards

1. All hanging and isolating systems shall comply and performed in strict accordance with the stipulations of the following Standards:

   (a) ASCE /SEI7
   (b) Fedral Specification WW-H1716
   (c) ASA Code for Pressure Piping
   (d) ASTM 575-73
   (e) MSS SP-58-67
   (f) MSS SP-69-66
   (g) ANSI Code for Pressure Piping

2. All hanging and isolating methods and techniques to be as indicated on the documents, in BOCA and SMACNA Guidelines for Mechanical Systems, 1982 Edition, NFPA 13, 1982 UBC, ANSI A 58.1, 1981, Title 2 CAC, GSA, and ATC-3. Where techniques are proposed that deviate from those detailed in the contract documents. They must be clearly detailed and stamped by Engineer.
11.1.4 Submittals

1. Submit the following for approval in accordance with the Contract, and Volume 1 Section B conditions of contract.

2. Product Data: Submit manufacturer's data including printed technical literature and catalog clippings, indicating maximum loads, dimensions, and recommended installation procedures.

3. Provide installation instructions, Drawings and field supervision to assure proper installation and performance.

4. Indicate locations of vibration isolation, insets, anchors, and guides on piping shop drawings.

5. Shop Drawings: Submit for review full detailed drawings and calculations indicating all methods and devices used.


11.1.5 Contractor Responsibilities

1. The contractor shall be responsible to secure from the approved manufacturer of vibration isolation control equipment to have the following responsibilities:

   (a) Determine vibration isolation sizes and locations.
   (b) Provide piping and equipment isolation systems as scheduled or specified.
   (c) Guarantee specified isolation systems deflection.

2. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1/2 G load in any direction for all rigidly and resiliently supported equipment, piping and ductwork without failure and permanent displacement of the equipment. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section must be approved for individual equipment units and is acceptable only if above acceleration ratings are certified in writing by equipment manufacturer and stamped by licensed civil or structural engineer and are approved by the Engineer.

11.1.6 General Information

1. It is the objective of this specification to provide the necessary design for the control of excessive noise and vibration in the building due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork or conduit. The installation of all vibration isolation units, and associated hangers and bases, to be in accordance with the details shown on Drawings, specifications and equipment manufacturer's instructions.

2. All vibration isolators to have either known non-deflected heights or calibration marking so that, after adjustment, when carrying their load the deflection under
load can be verified, thus determining that the load is within the proper range of the device and that correct degree of vibration isolation is being provided according to the design.

3 All isolators to operate in the linear portion of their load versus deflection curve. Load versus deflection curves to be furnished by the manufacturer and must be linear over a deflection range of not less than 50% above the design deflection.

4 The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, not to differ from the design objectives for the equipment as a whole by more than + 10%.

5 All neoprene mountings to have a shore hardness of 30 to 60 +/-5 after minimum agings of 20 days for corresponding overaging.

11.2 PRODUCTS

11.2.1 Hangers, Supports Anchors and Guides

1 The Engineer must approve method of hanging before work is started. The contractor must make sure that all hangers and supports are properly and permanently connected to building structure. All structural hanging materials, except variable spring units, must have a safety factor of 5 built-in.

11.2.2 Vibration Isolation

1 All plant shall be isolated from the building structure and the supports isolated from other items of equipment.

2 Package units, Condensing units, VRV outdoor units ... etc. shall be provided with suitable anti-vibration mountings. The anti-vibration mountings shall be installed in accordance with the maker's recommendations and the Mechanical Contractor shall ensure that the performance and type of isolator is suitable for the machinery to be installed.

3 Package units, Condensing units, VRV outdoor units shall have anti-vibration mountings in the following form:

4 Multi-layer rubber pads with square grid convolutions on both sides, spaced with steel Shims and of a thickness to suit the points of uniform loading of the plant item, but of a minimum thickness of 32 mm spaced not more than 750 to 1000 mm apart.

5 The condensing unit of split unit shall also have similar A.V. pads as described above. However, the thickness shall be 10 mm.
11.3 EXECUTION

11.3.1 Installation

1 General: Hangers or clamps installed in contact with copper or brass pipe, to be of copper or provide lead or fiber shields between iron hangers and clamps to prevent electrolytic corrosion.

2 Furnish and install auxiliary steel required for pipe, conduit, cable tray, trapeze, supports, etc. Chain straps, perforated bars, wire hangers or expansion shields are not permitted.

3 Prime Paint: All black iron hangers to be installed underground, including rods, inserts, clamps, stanchions, brackets, etc., with zinc chromate, before installation.

4 Anchor Points: Provide to permit the piping and raceway system to expand and contract freely in opposite directions from the anchored points. Anchors may be double bolt riser clamps and shall be located halfway between guide point and no less than 1 per 30 meters run.

5 Guide Points: Locate in piping system on either side of expansion joints and, or loops, as specified herein and shown on Drawings to permit free axial movement only in pipe main runs. Elbows at ends of straight pipe runs flanking expansion joints or loops are considered expansion joints. Expansion joints shall be installed to limit straight runs of hot water and hot water circulating pipe runs to 30 meters maximum.

6 Hanger Location:

(a) Copper Tubing
   (i) 35 mm over: Support a maximum of 3.0 m intervals
   (ii) Below 35 mm: Support a maximum of 1.5 m intervals
   (iii) Branch piping and conduit 1.5 and longer: Provide separate supports

7 Support Locations:

(a) Copper Tubing and Conduit: At each story height but not more than 3 m intervals.

(b) Connect pipe conduit and cable tray hangers and anchors to the building structure as follows:
   (i) Support piping only from building structural steel or approved galvanized steel inserts embedded in poured concrete.
   (ii) Where piping and raceway revisions are required and are approved after slabs are poured, piping 75 mm and smaller may be supported at intermediate points by "Phillips" or other approved 20 mm expansion bolts and shields, shields provided for main supports are not less than 6 m on centers.
(iii) Attach intermediate supports for piping and raceways 100 mm and larger to concrete beams or columns by means of 100 x 10 mm thick clip knee angles with 20 mm expansion bolt in shear (horizontal) and supporting rod at 90° from anchor bolt.

8 Isolation Systems: Must be installed in accordance with manufacturer's written instructions. Vibration isolators must not cause any change of position of equipment, piping or conduit resulting in piping stresses or misalignment.

9 HVAC equipment and piping to be isolated from the building structure by means of noise and vibration isolators as described herein.

10 All piping and conduit 50 mm and over located in HVAC equipment rooms from connected equipment for 15 m, to incorporate isolation hangers.

11 All HVAC piping and vertical risers to be isolated from the building structure by means of noise and vibration isolation guides and supports as described herein.

12 Each fan and motor assembly to be supported on a single structural steel frame. Flexible duct connections to be provided at inlet and discharge ducts.

11.3.2 Piping Isolation

1 Installation: Isolate the following piping outside the shafts as follows:

(a) Piping where exposed on roof.
(b) All water piping connected to reciprocating or rotating equipment up to 15 m from equipment connection.

2 The isolators to be installed with the isolator hanger box shall be attached to, or hung as close as possible to the structure.

3 The isolators to be suspended from substantial structural members, not from slab diaphragm, unless specifically permitted.

4 Hanger rods to be aligned to clear and not short circuit the hanger box.

5 Horizontal suspended pipe 50 mm and smaller shall be suspended by Type E isolators with a minimum of 9 mm deflection. Water pipe larger than 50 mm shall be supported by Type F isolators with a minimum of 25 mm (or same static deflection for the first three locations) as isolated equipment to which pipe connections, whichever is greater.

6 Horizontal pipe, supported at floor slab shall be supported via Type A, with a minimum static deflection of 25 m or same deflection as isolated equipment to which pipe connects, whichever is greater.

7 Vertical riser pipe supports under 50 mm diameter shall utilize Type H.

8 Vertical riser guides, if required, to avoid direct contact of pipe with building.
9 Pipe anchors, or guides where required, shall utilize resilient pipe anchors, to avoid direct contact of piping with building.

10 Risers way supports, where required, shall utilize two neoprene elements (Type G or H to accommodate tension and compression forces).

11 Pipe extension and alignment connectors: Provide connectors at riser takeoffs, cooling and heating coils, and elsewhere as required, to accommodate thermal expansion and misalignment.

12 Isolator Position: As close to building structure as possible, direct bolting is optimal.
   (a) Between the building structure and supplementary steel, if required.
   (b) Suspend isolators from rigid and massive support points.
   (c) Supplementary steel shall be sized for a maximum deflection 2 mm at center span.
   (d) Support water piping in shafts and floor supports entering shaft with Type G isolators or Type H pad to prevent direct contact of piping with building structure.
   (e) Guide and anchor piping in shafts, as required, with approved mounting designs incorporating Type H to pad to prevent direct contact of piping with building structure.

13 Additional Isolator Requirements: The minimum operation clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor to be 25 mm. Minimum operating clearance between concrete inertia base and housekeeping pad or floor to be 50 mm.

14 The equipment structural steel or concrete inertia base to be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine and isolators.

15 The isolators to be installed without raising the machine and frame assembly.

16 After the entire installation is complete and under full operational load, to adjust the isolators so that the load is transferred from the blocks to the isolators and so that all isolators are barely free, remove shims.

17 Isolation mounting deflection shall be the minimum specified.

18 Install equipment with flexibility in wiring connection.

19 Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to limit equipment start-up lateral motion to 6 mm.

20 Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are not isolation short circuits in the base or isolators.
11.3.3 Inspection

1. On completion of installation of all vibration isolation devices herein specified, the factory representative or professional Engineer retained by the Contractor to inspect the completed system and report in writing any installation error, improperly erected isolation devices or other faults in the system that could affect the performance of the system. Contractor to submit a report to the Engineer, including the manufacturer’s representatives final report, indicating all isolation reported as properly installed requiring correction. Include a report by the Contractor on steps taken to properly complete and correct the isolation work.
12. AUTOMATIC CONTROL & THERMOMETERS

12.1 GENERAL

12.1.1 Related Documents

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

12.1.2 Scope

1 Furnish and install a complete system of automatic temperature/humidity and other controls as herein specified and as indicated on drawings and section 22 part1 clause 1.8.5 System Description, Control and energy recovery techniques for a complete automatic control system that will achieve all functions and conditions specified.

12.1.3 Description of Work

1 Provide and install all electric and/or electronic components, controls, control devices, wiring, software, electronic devices, training, labor and supervision required to operate a fully integrated direct digital control (DDC). System as follows:

2 Remote and/or manual start/stop and status of mechanical system fan motors.

3 Stand - alone DDC controllers shall be microprocessor based capable of independent control of the systems and ready for connection with the BMS. Stand - alone controller (panel) shall be provided for all equipment as specified on drawings for the control and status of all fans used for life safety include:

(a) Smoke fans service underground parking and main reception,
(b) Supply and Extract fans service fire pump room,
(c) Fans service Generator room,
(d) Fans UPS / battery Room,

4 All DDC panel's and Roof top package unit , VRV units, condensing units , … etc (PLC or DDC) should to using same protocol protocol LON or BACnet and to be coordinated with BMS supplier to use same, In case of using different protocols,
a gate way shall be used without any extra cost.

5. ALL items specified in equipment schedule should be providing in one from the Previous DDC controller / panels.

6. Execution of work, equipment storage cleaning rubbish removal, etc., insurance and bonds shall be as required and directed by the project manager.

7. Be responsible for work until its completion and final acceptance; replace any of the same, which may be damaged, lost or stolen, without additional cost to the owner.

12.1.4 Quality Assurance

1. All items required for the automatic control shall be manufactured by firms regularly engaged in the manufacture of such products, and whose products have been proven to be in satisfactory service for not less than 5 years. All control devices, elements and software shall be provided by a single manufacturer.

2. Supervise installation staff with competent project manager who is fully trained in the installation of control equipment.

3. Single source responsibility of supplier shall be the complete design, program and installation supervision of the control system and shall include software debugging, proper calibration of each component in the entire system and hardware system check-out.

4. Supplier shall have an in-place support facility in Doha with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

5. All electronic equipment and wiring shall conform to the requirements of the civil defense regulation, governing radio frequency electromagnetic interference and be so labeled.

6. Secure all permits and inspection certificates and approvals and transmit same to owner at the completion of the project.

7. Comply with occupational safety and health Act. (OSHA), national fire protection (NFPA) requirements and applicable codes, DIN/VDE, IEC, BS, EN, NEC, UL, NEMA, IEEE and ANSI standards.

8. Control system shall be DDC type ready for connection with building management system.

9. Control system shall be supplied with 20% spare points for each type of I/O points and distributed as a percentage of the existing points.

10. each unit (Roof top package unit, VRV units, condensing units, Fans, heat recovery) control system shall be stand-alone, no matching points for different
units will be accepted.

12.1.5 Submittals

1. The following shall be submitted for approval (Submit 3 complete sets of documentation):

2. Manufacturer's Product Data: Submit manufacturer's product information on all hardware items along with descriptive literature for all software programs to show compliance with specifications.

3. Shop drawings: System wiring diagrams and layout of controls with sequence of operation for each system as specified.

4. System configuration diagram showing all panel types and locations. The diagram shall be made for each control system, which shall indicate the proper sequence of operation and range of the controls for all cycles and shall also indicate a complete description of the automatic operation of each control system. The description would include the duty of each thermostat, valve, switch, etc. incorporated in the control system. A schedule and illustration of all control instruments and equipment including control panels devices for each system.

5. Where installation procedures or any part thereof, are to be in accordance with the recommendations of the manufacturer of the material being installed.

6. Printed copies of these recommendations shall be reviewed with the owner and the installation supervisor prior to installation of the item will not be allowed to proceed until the recommendations are received and approved by the owner.


12.1.6 Product Delivery and Handling

1. Do not store exposed to weather. Protect wire and cable against damage from work of other trades. Cover with suitable approved type material to avoid damage.

12.1.7 Coordination of Work

1. Coordinate work with that of the contractor and with mechanical and electrical trades. Schedule work in accordance with the construction schedule so that all work will be installed at the proper time without delaying completion of the project.

2. Check the contract drawings and specifications for all of the other trades so as to be familiar with the various items of apparatus and equipment, which will be furnished or set under the different contracts that require connections or other coordination.
3 Furnish to the Architect detailed advance information regarding requirements related to work under other division and/or sections. Furnish sizes, color, accurate data, and locations of any and all pads, pits, chases and other special openings required. Cost due to late installation or improper coordination of work is the responsibility of the delinquent trade.

4 Carefully check space requirements with other Sub-contractors to insure that equipment can be installed in the spaces allotted for same.

12.1.8 Contractor's Qualifications

1 The Control contractor shall have a minimum of five years experience in the design and installation of similar systems to that specified herein and shall submit evidence of this experience with the bid proposal.

2 The control manufacturer shall have a local office in Doha, staffed with factory trained engineers fully capable of engineering, supervising installation, system start-up and commissioning providing owner training and routine and emergency maintenance service on all system components. A complete spare parts inventory and all necessary test and diagnostic equipment shall be available at the local office.

3 Software must be field tested and documented. As evidence of software quality and documentation, all bids shall be accompanied by descriptive literature of each software application program.

12.2 PRODUCTS

12.2.1 Equipment Summaries

1 The system as specified shall monitor, control and calculate all of the points and functions as specified in the Equipment Summaries at the end of this section, the motor control Schedules and control and electrical drawings.

12.2.2 Automatic Control - Description

1 Furnish and install as herein specified a complete electric/ electronic automatic control system. All controls are to be fully modulating type, except where noted otherwise. The system shall be complete in all respects including thermostats, relays, valves, dampers, etc., to provide the functions as described, regardless of whether or not said devices are specifically mentioned hereinafter. The system shall be installed complete in all respects by competent mechanics regularly employed by the manufacturer. All line voltage wiring for relays, damper switches, fire-states and interlocks shall be provided and installed as specified under another section of the work.

2 All the controls must be the product of one manufacturer. All automatic control valves shall be manufactured by the control manufacturer and installed as specified under another section of this specification.
3 All thermostats shall be of the fully proportioning type with adjustable sensitivity operating over the controlled device throttling range.

4 All valves shall be fully proportioning unless otherwise specified, quiet in operation, and shall be arranged to fail safe in normally closed position, in the event of power failure. All valves shall be capable of operating at varying rates of speed to correspond to the exact dictates of the controller and variable load requirements. Provisions shall be made for valves operating in sequence with other valves or damper operators to have adjustable operating ranges and starting points to provide flexibility of adjustment in sequencing and throttling range. All valves shall be equipped with throttling plugs and renewable composition discs. Valves shall be sized by the control manufacturer and guaranteed to meet the heating or cooling requirements as specified. All water valve bodies shall have the same pressure characteristics, as the pipe in which is it installed.

5 Furnish and install adjacent to each mechanical system, as herein specified, control panels of steel and with welded angle iron brackets, wall or floor type, on which shall be flush mounted the associated controls as previously described. The basic background color of the panel shall be as approved by the Architect. Panels shall be fully enclosed with hinged locking front door and canopy light for each panel. The panel shall contain all controllers, relays switches, etc. Details of each of these panels shall be submitted for approval prior to fabrication, locations of each panel are to be convenient for adjustment and service and all such locations are to be approved prior to installation. Provide engraved nameplates beneath each panel mounted control device and air gauge, clearly describing the function of said device.

6 Plastic laminated control schematic drawings for the system shall be hung at each local control panel.

7 The control system shall be in accordance with the description of system operations and/or detail information shown on the plans.

8 Damper operators shall meet the same requirements as valve operators with respect to operating at variable rates of speed, etc. and shall have external adjustable stops to limit the stroke in either direction if required for proper operation. All damper operators shall be of sufficient power to overcome friction of damper linkage and air pressure acting on blades and with mounting arrangement for location outside of the air stream, wherever possible.

9 Stand - Alone DDC Controller (SDC)

(a) Each controller shall be a microprocessor based, multi - tasking, real time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. The controller shall be capable of performing its building equipment status, monitoring and control responsibilities (analog and discreet input or output) and facility management routines independent of other controllers in the network.
(b) The stand-alone controller shall be capable of interfacing and compatible with the BMS and fire Alarm and life Safety Systems.

(c) Stand-alone controllers shall allow temporary use of portable input/output devices without interrupting the normal operation of permanently connected devices.

(d) The operator shall have the ability to manually override automatic or centrally executed commands at the stand-alone controllers. The override controls shall be operable whether the panel processor is operable or not.

(e) Stand-alone controllers shall provide local status indication for digital and analog input and output valves on the outer panel door (without the need for an operator I/O device).

(f) The stand-alone controllers shall be provided integral power conditioners filters to protect against voltages surges and transient noise.

(g) In the event of the loss of normal power, there shall be an orderly shutdown of all stand-alone controllers to prevent the loss of database or operating system software. Battery back-up and/or non-volatile memory shall be incorporated to preserve critical controller data and support the real-time clock and volatile memory for a period of 7 days. Upon restoration of normal power the controller shall automatically resume full operation without manual intervention.

(h) The controller must be able to operate within a temperature range of 0 to 50°C and 90% RH. I/O modules shall be capable of operating within a temperature range of 0 to 70°C and 90% RH.

10 Field Installed Devices:

(a) Temperature sensors (space, duct, water, etc.)

(b) Humidity sensor

(c) Pressure sensors (air and water)

(d) Damper actuators

(e) Automatic control valves

(f) Flow sensors (air and water)

(g) Smoke detectors

(h) Differential pressure sensors (air and water)

(i) Electric current sensors

(j) Air Quality sensors

12.2.3 Software

1 All necessary software will be provided to form a complete operating system with all capabilities, delineated or implied, to satisfy the requirements of the hardware, software and sequence of operation specified in this section.
2 Stand - Alone DDC Controllers Software:

(a) All standard and/or custom software provided for the stand-alone controllers shall be an integral part of the controllers, residing in the stand-alone controller memory and shall not be dependent upon any higher level computer for execution.

(b) The controller shall have sufficient memory to support its own operating system, software and databases in order to perform the following functions and applications.

(c) Control processors - ability to monitor analog and digital inputs and controls devices to perform the following pre-tested control algorithm functions.

(i) Two-position control
(ii) Proportional control
(iii) Proportional plus integral control
(iv) Proportional integral plus derivative control
(v) Control loop tuning (optional)
(vi) Energy Management Applications
(vii) Time- of-day scheduling
(viii) Calendar-based scheduling
(ix) Holiday scheduling
(x) Temporary scheduling overrides
(xi) Start-stop Time optimization
(xii) Automatic Daylight savings time switch over
(xiii) Night setback control
(xiv) Peak demand limiting
(xv) Temperature-compensated duty cycling
(xvi) interlock

(d) Alarm Management Applications - monitor, store and direct alarm information to other operator devices.

(e) Historical/trend - data - historical data collection utilities shall be provided to manually or automatically sample, store and display system history data for selected analog and digital inputs and output points (physical or calculated) for trending, totaling and uploading to operator workstations.

(f) Maintenance Support Applications - the controller software shall have the ability to count and totals events such as the number of times a fan system is cycled on and off the user shall have the ability to define a warning limit to generate a user-specified message when the limit is control routines.

(g) Custom process - the controller shall be able to execute custom job
specific processes defined by the user, to automatically perform calculations and special control routines. The custom process may be triggered based on any combination of conditions as time interval time-of-day, date events, alarms and other processes.

(h) Operator I/O - the operator shall have the ability to add various I/O devices to any controller and link any input to any output or algorithm in use in the system.

(i) Manual Override Monitoring - event initiated and manual override capability shall be provided. Manually initiated overrides shall be removed manually; the controller shall monitor the status of all overrides and inform the operator that automatic control has been inhibited.

12.2.4 Control Systems

1 General: The setting of items of control equipment shall always be such that access for adjustment and maintenance purpose is not impeded. However, where items of control equipment are mounted in accessible positions within normally occupied areas, the control items shall be provided with means to discourage unauthorized interference. Control systems shall be arranged such that, in the event of electrical power failure or other abnormal operating conditions, inherent fail safe features prevent potential conditions raised hazards.

2 All Controls shall be capable of operating in ambient conditions varying between 0-50 \(^\circ\) C and 95 % RH.

3 All Control devices (unless provided with a flying lead) shall have 20-mm conduit knockout. Alternatively, they shall be supplied with adapters for 20-mm conduit.

4 The Contractor shall include the following ancillary items:

(a) Weather protection: All devices installed in ambient condition.

(b) Pipe work Immersion: Corrosion resisting pockets of length suitable for the complete active length of device, screwed 1/2” or 3/4” BSPT suitable for the temperature, pressure and media.

(c) Duct Mounting (metal or builders work): Mounting flanges, clamping bushes, couplings, lock nuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

(d) Control and measuring devices shall have the following limits of accuracy:

(i) Temperature: \(\pm 0.5\) °C.

(ii) Pressure: \(\pm 5\) % of measured value.

(iii) Humidity: \(\pm 5\) % RH.

(e) Averaging elements shall be used on ducts having a cross-sectional area exceeding 0.6 m\(^2\) and shall have a minimum capillary length of 5 m. The Capillary element shall be serpentine across the whole duct. Where the span of the element is less than 1 m then it shall be fixed with purpose
mode clips and may be unsupported across the duct. Where the span of the element is above 1m then it shall be supported on unistrut or similar rigid support.

(f) Sensors (Room and Duct)

(i) Temperature sensors shall be generally of the PTC type for two wire-screened connections to the associated controllers.

(ii) Humidity sensors shall sense changes in relative humidity by mechanical means, conversion to an electrical output shall be by a friction free inductive coupling. Connections shall be by screened wiring to the associated controllers.

(iii) Combined temperature and humidity sensors shall require six wire connection to the associated controllers and shall not be susceptible to interference. Output of temperature and humidity sensors shall be compatible so that the controllers are interchangeable.

(iv) Sensors shall consist of a base plate to which the electrical connections are made. The sensors housing shall plug into the base so that it can be removed easily without disturbing any wiring connections. Combined temperature and humidity sensors shall plug into a common base plate.

(v) Air Pressure sensor shall have protection standard IP54 in accordance with IEC529 with max. admissible operating pressure 0.5 bar. Pressure sensor should have two ports and the differential pressure between the two ports will cause a corresponding deflection in the spring-loaded membrane. This movement is electromagnetically transduced and converted by the built-in electronic system into a voltage signal compatible with the controller. Pressure sensor accuracy to be not less than \( \pm 5\% \) of measured value.

(vi) CO Sensor: The sensor shall measure the concentration of carbon monoxide in air by means of electrochemical sensors. The measurement of the concentration is based on the principle of an electrochemical cell in which the gas to be detected is reduced or oxidized. This reaction causes a voltage change between the measurement electrode and the reference electrode. This difference can be used as a measurement signal.

(g) Temperature Sensors (Immersion)

(h) All immersion sensors shall consist of a rugged die cast aluminum base plate which rigidly holds an immersion tube of 76 mm in length with “BSPT” screwed connection. A clamp-on protection shall cover the cable connection, which shall be suitable for a two-wire connection. It shall be possible to replace the sensor without draining the system.

(i) Pressure Sensor (Immersion) the Immersion pressure sensor will measure the main supply and the main return chilled/hot water. Immersion pressure sensor shall stand the operating pressure and temperature.
(j) Air Pressure Switch: The pressure switch shall comprise two chambers connected to a diaphragm, the chambers of the device shall be arranged so that the device can be used as a static pressure or differential pressure switch as specified. Connection to the device shall be by means of a plastic tube to the points to be measured on the duct via a plastic serrated coupling. The pressure switch shall have a SPDT potential free switch and be supplied complete with duct sampling connections and plastic connecting pipe.

(k) Control Valves: For accuracy of control all modulating valves serving the air handling units shall be of the magnetic type with a speed of response not exceeding 10 seconds and rangeability of at least 500:1 at valve design flow for optimum energy saving. These valves shall incorporate a pressure balancing bellows. Valves bodies shall be according to valves specifications (refer to section 15520). Valve sizes 2” and smaller shall be screwed and supplied with union fittings. Valve sizes above 2” shall be flanged. Valves shall be of the 2-way type as required. The valves shall be equipped with a hand wheel to allow for manual positioning of the valve in the absence of control power. Valves shall be of the spring return type that will move to normally close position upon stop of control without applying electrical power. Valves shall be supplied complete with actuators and linkages and be supplied to site ready assembled and adjusted for stroke.

(i) Control signals 0..10 v or 0..20 v phase cut 1..20 ma DC

(ii) Nominal pressure 16 bar

(iii) Operating and closing pressure 10 bar

(iv) Max. Leakage .05% Kvs

(l) Damper Actuators: Damper actuators shall be of the direct coupled type for either modulating or two or three position control. Actuators shall stroke by a rotating motion of a reversible overload-proof synchronous motor. Control voltages shall be either 24 VAC or 0-20 VDC as required by the application. All actuators shall have a hand operating facility and position indication marked 0-10 indicating 0-100%. On modulating types the direction of operation and stroke limitation shall be adjustable without mechanical changes in the linkage. Modulating and two position types shall be with spring return type, the spring return time shall not be more than 3 seconds.

(m) Variable speed drive unit: Adjustable frequency drive AFD unit, each approved and suitable for installation of the scheduled motors. Ensure that drives and motors are approved by respective manufacturers as compatible.

(n) The adjustable frequency totally digital drive shall be of the pulse width modulated PWM type utilizing insulated gate bipolar transistors in the inverter section of the drive and shall have the following minimum specifications:

(o) Suitable for use with standard of high efficiency 415 volt, 3 phase, 50 Hz motors.
(p) IP 43 wall or floor mounted enclosure.

(q) 415 volt 15%, 3 phase, 50 Hz input power supply and 0-415 volt, 3-phase 0.5 to 120 Hz output. No transmitters shall be used on either the input or output of the adjustable frequency controller.

(r) Input transient protection by line reactors and/or line filters as required harmonic distortion to 3% at each VSD input. Total harmonic distortion value shall be calculated according to the actual selection by the manufacturers of drivers.

(s) Complete with an incoming, horsepower rated, non-automatic circuit breaker with an operating mechanism which is door interlocked and pad-lockable in the open position. Input line fuses whose characteristics are coordinated with the drive’s electronic protection circuits so as not to blow under normal output faults such as over-current, short circuit and ground fault.

(t) Line over and under voltage protection, phase loss protection and phase unbalance protection.

(u) Inherent short circuit protection for line to line and line to ground faults. If either of these faults should occur in the output of the drive, the drive shall safely shut down without damaging any power circuit devices. Controllers utilizing fuses or isolation transformers to provide this protection shall not be acceptable.

(v) Electronic instantaneous over-current protection.

(w) Current limit, of the high performance inner current loop type, adjustable between 0 and 110% of rated output. Independent adjustment shall be provided for both motoring and regenerating operating modes.

(x) A continuous duty service factor of 100% of rated output current with overload protection rating of 150% for one minute.

(y) Minimum efficiency of 98% at maximum load and speed.

(z) Minimum line side displacement power factor of 0.98 at all speeds.

(aa) Maximum ambient temperature of 52°C.

(bb) Maximum relative humidity of 95% non-condensing.

(cc) Maximum altitude of 1000 m for rated output.

(dd) Adjustable minimum motor frequency of 0 to 50 Hz.

(ee) Adjustable maximum motor frequency of 0 to 50 Hz.

(ff) Separately adjustable acceleration and deceleration ramps from 0 to 1800 seconds (0 to 100% speed).

(gg) Controller internal over temperature protection.

(hh) Motor protection including electronic motor stall protection to trip the drive off should a motor overload or stall condition occurs.

(ii) Automatic restart after an inverter fault trip; the drive shall attempt to restart automatically three times with lock out after the third attempt if a
restart has not occurred this feature can be defeated if auto restart is not required.

(jj) Rotating motor restart feature; this feature will allow a motor unit which has been shut down or has fault tripped but is still rotating to be restarted without first stopping the motor unit. The drive shall restart the motor at the speed at which it is rotating and then reaccelerate to the speed called for by the speed reference signal.

(kk) Capable of running without a motor connected for setup and testing.

(ll) Capable of accepting the opening of a remote motor disconnects while running without causing damage to the drive.

(mm) Auto restart after power outage (provided that run enable is maintained).

(nn) Three frequency reject points to prevent the pump from operating a resonant speed; both the center frequency and the bandwidth shall be adjustable.

(oo) Thermistor relay for all motors. If the relay operates due to a motor over temperature condition, the drive controller shall shut down and illuminate a door mounted (motor over-temp) pilot light.

(pp) 30 cycle ride through.

(qq) Provide automatic/manual signal follower for a 4-20 mA and 0-10 VDC reference.

(rr) Input current limiting HRC fuses to suit short circuit interrupting capacity of equipment; fuse characteristics shall be coordinated with drive’s electronic protection circuits so as to not low under normal output faults such as over-current, short circuit or ground fault; refer to motor starter/MCC schedules.

(ss) Complete with an incoming non-automatic circuit breaker or un-fused disconnect with operation mechanism, which is door interlocked and pad-lockable in open position.

5 Principle of Control System: Controls shall be built up of modular microprocessor based DDC control units. The DDC system must be self-sufficient and ensure the automatic operation of the electrical and mechanical plant. It should be taken into account that the operation of the electrical and mechanical plant must be optimized to ensure energy efficient operation. The DDC units must be programmable and stand-alone (microprocessor for each Panel) and ensure a fully automatic operation of the electrical and mechanical plant, which must allow for a rational operation and fast system response. The units must be fitted with a powerful processor with high processing speed, a suitably sized memory capacity and a modular graphic programming language for the project specific application programs.

6 The programmable language must be self-explanatory and self-documenting. The programming language must further contain all function elements that allow the versatile connection of control and interlock function, the application of control algorithms such as P, PI, PID, the simple and precise setting of parameters, alarms and limit values. For the communication between the DDC modules, a
bus-system must be used which provides a peer to peer communication with fast and secure data transmission. The communication between the individual DDC units must stay fully operational even when the upper levels and/or individual DDC units fail.

7 Standard basic functions resident in each programmable plant controller shall include the following:

(a) Basic functions (software modules) which can be combined by means of application - programs to form any control and interlock strategy required.

(b) Control functions are not limited to:

(i) Universal set point calculation
(ii) Modulating control functions, 2 point, P,PI,PID
(iii) Additional modulating sequence
(iv) Analog or digital output steps with selection logic, manual override, interlock, time functions, limit control, D/A conversion
(v) Universal heating curve (with adaptable algorithm)
(vi) Compensated heating control
(vii) Slow rate limiter
(viii) Programmable output block
(ix) Channel selector (for individual switching of system parts)
(x) Heating logic (summer/winter switch)
(xi) Demand dependent switch Time clock (8 channels, 24 hours, 7 days, yearly switch functions)
(xii) Run time totaliser
(xiii) Ring counter
(xiv) Data transmitter
(xv) Alarm handler
(xvi) Timer

(c) Energy management functions are not limited to:

(i) Self- adaptive optimizes.
(ii) Adjustable dead bands.
(iii) Duty cycling.
(iv) Air quality control.
(v) Time control.
(vi) Demand related reset functions.
(vii) Enthalpy control, etc.
8 DDC Controller: DDC controller must have the following additional functions:

(a) Free selection of range and unit (dimension) of all signals (measured values, accumulated values, calculated values etc.).

(b) Free allocation of access protection in accordance with operating priorities.

(c) Free definition of manual override priorities (software) from operator terminal and/or management station (if included).

(d) Graphic documentation of application programs in function plans (structure diagrams). The signal paths must be clearly identifiable for operators without special programming knowledge.

(e) The processing speed must ensure precise and non-oscillating control of all common building services processes.

(f) A self-monitoring of the processor and self-test or correct functioning of the functions must be automatic.

(g) If - for any reason - the communication between the control modules should be interrupted by wire breaks/disconnection etc., then each control module shall be to continue to function autonomously, to provide all functions including time-of-day based routines.

(h) Each control module shall have a real time clock with 8 time channels, which are day and date programmable. The clocks shall be self-synchronizing when control modules are connected together on the control system communications network, thus only one clock needs setting for the whole system.

(i) The clocks will allow up to 99 switch times spread over the 8 channels.

(j) The clocks shall be capable of EST/GMT+2 changeovers on the basis of either manual intervention or automatic time program.

(k) The system shall be capable of two-way communication with intelligent terminal unit controllers. This will allow transmission of time, morning boost, purge and summer/winter compensation signal from systems to the terminal unit controls. Conversely, the terminal unit controls shall be capable of resetting the systems controls by transmission of heating/cooling demands signals.

(l) The transmission of signals from the processor interface must be carried out via universal (analogue or digital) and digital input/output. The connection of the DDC units to the data bus must be provided as standard local operation. Each DDC unit and communication and control unit for individual room controller where installed must be connectable to an operator terminal directly and/or remotely via the data bus. The operation must be menu driven and interactive via an easy-to-understand keyboard and alphanumeric display.

(m) The operating concept must be structured such that data can be accessed at individual operating levels in accordance with the associated access authority.

(n) The DDC controller processor shall have a cycle time not exceeding
500ms.

(o) The DDC controllers shall be supplied complete with means of communicating with other controllers in the building without necessity of adding components later on.

(p) General DDC Controller Requirements

(i) Data must be kept even in the event of power failure. Power failures and peak loads must not cause data loss. The controller shall store its operating system in EPROM to ensure integrity during a power failure (max. 10 years).

(ii) Permanent self-monitoring of the system must be ensured by integrated test and service functions. All controllers shall have a software override facility, stored in the built in EPROM. The DDC controllers shall be available in several modules of differing point size, all models shall be fully compatible in size and operation to provide for further expansion. It shall also be possible to plug in controllers with a larger point capacity into the lower capacity base up to the maximum module size. Thereafter it shall be possible to arrange controllers adjacent to one another, the arrangement automatically making any necessary bus connections between the controllers.

(iii) DDC Control Module Technical Requirements:

- Processor memory capacity: 8 bit/16 bit structure
- EPROM for operating system and function library: 64 bytes
- RAM for temporary data: 8 K bytes.
- EPROM for project specific application program: 8 K bytes.
- Resolution AID, DIA converter: 12 bit = 1/4096
- Supply voltage: 24 VAC 10%
- Frequency: 50-60 HZ
- Control accuracy: 0.5% (of Ue O-10V).
- Scan cycle, typical value: 200 ms - 500 ms.
- Maximum update time: 900 ms
- Transmission rate between modules and high order systems (adjustable): at least 9600 baud
- Number of connectable modules per bus: 16
- Data storage during power failure.
(q) Structures and parameters  
10 years

(r) Time  
7 days

(s) Radio interference protection in accordance to  
VDE0871B

(t) Protection class  
III

(u) Protection standard  
IP00

(v) Ambient temperatures

(w) Operation  
0 °C to 50 °C

(x) Transport & storage  
25 °C to 70 °C

Number of local operator terminals per bus  
15

9 Connection of Peripheral Devices: The signal adaptation and the transmission of signals between the peripheral devices (such as sensors, control devices, starters etc.) and the DDC system shall be achieved via terminal module carriers and plug in terminal modules. The peripheral devices shall be connected to the terminal module carriers by screw terminals. The connection to the DDC system from the terminal module carriers must be by plug-in ribbon cables. For a direct (independent of DDC unit) override control (safety interlocks) of the connected inputs and outputs (control devices etc.) via external voltage-free contacts, additional connection terminals must be provided for the output modules. Individually plug-in terminal modules are required for each data point, so that the possibility of isolating the units from the system facilitates the maintenance and service work and ensures that system can be expanded or modified depending on the demand. Where interfacing relays are required between the control manufacturer’s equipment and other items of system, the control manufacturer shall include the cost of these items in his quotation.

10 Terminal Modules: The terminal modules must meet the following requirements:

(a) Electrical separation between the electrical and mechanical system and the DDC System.

(b) Integrated manual/automatic switch for manual emergency operation independent of the DDC System.

(c) Permanent display of operating stages by way of integrated LED.

(d) Clear labeling data points.

(e) Possibility of separating the electrical and mechanical power from the DDC system by removing individual terminal modules.

(f) Connection of all active and passive standard signals (0…10V, 0 (4)... 20 ma, Pt 100 etc.).

(g) Counter inputs.

(h) Outputs to all standard control devices (modulating, reversible etc.).

(i) All output terminal modules shall provide local status indication for both
digital and analogue functions.

(j) Terminal modules shall have the capability of including manual override switches on them to facilitate commissioning, testing and fault finding and enable them to be operated independently of the DDC system.

11 Local Operator Terminals: A local operator terminal shall be provided to provide menu-driven displays using the English language, enabling the operator to identify and read all set point values, sensed values, calculated values and status conditions throughout the control system. The same terminals shall enable an operator with suitable access authority - to change set points, controller parameters, timetables and output statues. The operator terminal shall be capable of being placed at any outstation or remotely, powered by a local transformer. It shall be capable of being mounted on control panel door, back plate mounted, wall mounted or portable, supplied with carrying case. Additional local operator terminals shall be able to be added to each control system, so that up to 15 operator terminals may be connected to each bus at any time, all of which shall be able to address any function on any control module within the particular communication bus. Any alarm condition occurring at any control module shall be notified to all local operator terminals on the same bus, to give visual and audible indication of the existence of an alarm, which may be subsequently identified and acknowledged. Each local operator terminal shall provide three levels of access to all functions and parameters, all of these functions and parameters shall be suitable for individually allocable for a particular operating level when the functions are programmed into the main system controllers. All Operator terminals should have three operating levels with a different password for each level.

12 Space Requirements for Devices: The space required to install the above devices in the control panels is to be assessed from the technical data for above devices. The required terminals connected in series from part of the delivery. The number of cables to be connected. The wiring between terminal strips and terminal module carriers is to be carried out according to the respective regulations. The necessary voltage supply is to be included in the control panels price. The installations of the DDC-system manufacturer must be observed.

13 Control Panels Section for DDC-Components should be in robust steel construction, with mounting plate, doors and hinges inside. Size and color of the control panel (as specified by the Construction Company) complies with the design of the power distribution system. The space required is to be assessed from the technical data of above devices. For the interface between the control section and the power section, a terminal strip is required. The necessary voltage supply is to be included in the control panels price. The installation regulations of the DDC-system manufacturer must be observed. Included are also the terminals connected in series, the necessary small accessories and the fastening equipment, mounted, wired and factory-proven.

14 Equipment Control Sequence: (Refer to drawing K-00-004 for detailed sequence of control for all equipment)
12.3 EXECUTION

12.3.1 Installation

1. The contractor shall furnish and the system shall include all hardware, software, all interconnecting wiring and conduit as required for a fully operational system as specified, and be in accordance with local and national codes. Installation of all conduit, wire, sleeves, outlet boxes, junction boxes, inserts, anchors system devices, etc., shall be in accordance with the appropriate requirements of the electrical section of the Base Building Specifications and in accordance with applicable sections of the current edition of the application local codes for signaling systems.

2. Furnish and install all low voltage alarm wiring from alarm actuators (temp. flow, level or pressure) to the local panels. Where alarm actuation is shown to provide more than one function, the manufacturer shall provide the necessary relays in the local panel and interconnecting wiring between the local panel and the motor control center terminal strip to accomplish the duel function.

3. The contractor shall be responsible for installing and furnishing all wiring (low or line) between the local panels and the motor control panel terminal strip.

4. Furnish and install all control wiring required for electrically interlocking fans not previously interlocked in motor control centers. (See motor and control Schedules).

5. The contractor shall furnish and install in the system ductwork, all required motorized dampers and shall wire the damper actuator motors to the supply or return fan.

6. The contractor will provide all line voltage wiring in connection with the automatic control.

7. The entire control system shall be installed by skilled electricians and mechanics, all of whom are properly trained and qualified in this work.

8. Supervision and checkout of the system shall be executed by factory trained engineers and technicians directly employed by the equipment supplier.

9. Energy metering system location and installation to be as per manufacturer instruction. System to be as manufactured by Aqua Metro or approved equal.

12.3.2 System Start - Up, Acceptance and Support

1. Upon completion of the installation the Equipment Supplier and Contractor shall start - up the system and perform all necessary testing and debugging operations and then notify the Architect that the control system is ready for initial acceptance testing.
2 Submit a detailed acceptance procedure to the Architect in writing, to demonstrate compliance with specified system requirements. This procedure shall be submitted at least sixty (60) days prior to the period for the initial acceptance testing for approval.

3 An acceptance test in the presence of the Architect shall be performed. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted by beneficial use and placed under warranty.

12.3.3 Documentation

1 Provide complete system documentation at acceptance time as specified herein. Documentation shall be provided in two sets unless specified otherwise, elsewhere in this specification. Documentation shall include the following:

(a) All data specified in the submittal section of this specification in its final as built approved form.

(b) As built wiring diagrams or wire lists of the complete field installed system components and devices.


2 This manual shall be indexed and shall have a separate section for each operator function.

12.3.4 Employer Instructions

1 Provide six copes of an operator’s manual describing all operating and routine maintenance service procedures for the system. This contractor shall provide 40 hours of on-sit training to the Owner’s designated representatives in these procedures after system acceptance. These instructions are to be conducted during normal working hours at a time mutually agreed upon by the Owner and this contractor and shall be performed by factory trained representatives of the control manufacturer. The instructions shall consist of both hands-on and classroom training at the job site. An additional training session of (5) 8-hour days shall be provided during the first year to answer operator questions and review modify system operations.

12.3.5 Warranty

1 The system including all hardware and software components shall be warranted for a period of one year following the date of final acceptance. All defects arising during this warranty period shall be corrected without cost to the Owner.

2 All applicable software as detailed in this specification shall be updated by this contractor free of charge during the warranty period. This shall ensure that all system software will be the most up-to-date software available from the equipment supplier and manufacturer.
3 Problems, which occur within, approved hardware or software shall be corrected in an appropriate fashion under warranty. Any such occurrences shall not void previous approval however the control contractor shall be responsible to attend to and remedy such items within a reasonable amount of time.
13. THERMOMETERS

13.1 GENERAL

13.1.1 Related Documents

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 "Air Conditioning Refrigeration and Ventilation" of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations are to be used in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

13.1.2 Scope

1 Furnish and install piping thermometers and gauges as requested by the contract and as specified herein, complete with all accessories.

2 Extent of the thermometers and gauges is indicated on Drawings.

13.1.3 Submittals

1 Submit the following for approval in accordance with the Contract, and Volume 1 Section B conditions of contract.

2 Shop Drawings: Shop drawings shall indicate sizes, types, and material with detail and attachment installations.

3 Samples: Provide samples when requested by engineer.

4 Schedule: Schedule of thermometers and gauges for approval. The submission shall include the type, location, ranges, scale reading, construction data and stem details of the devices.

5 Product Data: Provide manufacturer's product data, including places of origin, printed technical literature, installation instructions and catalog clippings for each type.

13.2 PRODUCTS

13.2.1 Thermometers

1 See "Automatic Control" for description of all thermometers to be provided by automatic control manufacturer. Supply thermometers as indicated on the Drawings and at all thermostat bulbs in ductwork, casing, piping, etc., as required.
for the automatic control systems. These thermometers shall be located adjacent to the respective thermostats so that where the thermostat is remotely located, it shall be necessary to use a remote reading type thermometer. Where the thermostats are located as part of the temperature control panel, it is not necessary to install other thermometers.

2 Duct Type Thermometer: They shall have a union connection with a flange and a 229 mm case with a 152 mm stem where mounted on uncovered duct work and casing and a 305 mm stem where mounted on covered ductwork, casing etc. They shall be provided with and mounted on an extended neck with flanges flush with the surface of the covering. The Engineer shall approve the scale range of thermometer.

13.3 EXECUTION

13.3.1 Installation

1 Furnish and install pipes thermometers with separate sockets in the following locations (This applies to all systems as described in the specification).
   (a) Fresh air ducts and mixed air plenums
   (b) Supply fan discharge air
   (c) Suction side of recirculation fans
   (d) Provide and locate as required and as per manufacturer instructions.

2 Care shall be taken that there are no air leaks around the thermometers stem where it passes through ductwork, casing or through masonry wall.

3 Thermometers shall be so located as to be easily read from the floor level and shall be of the adjustable inclination type to meet this requirement.

13.3.2 Warranty

1 The Contractor shall provide a warranty of two years for parts and workmanship following start of beneficial use of acceptance, whichever comes first.
14. TESTING, ADJUSTING AND BALANCING

14.1 GENERAL

14.1.1 Related Documents

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

14.1.2 Scope

1 Provide all required instruments, documentation and technical staff to execute work as specified in this section and to the satisfaction of the Engineer.

14.1.3 General

1 It is the intent of this section of work to obtain complete inspection, testing, commissioning and balancing of systems including each and every fan, air handling unit, fan coil unit, trunk duct, branch duct, coil, water systems, etc.

2 Air systems leakage shall not exceed leakage rates specified.

3 Total system testing, adjusting and balancing shall be done by and on the responsibility of the contractor.

4 The contractor must employ an independent company specialized in testing and balancing of air conditioning systems to test, regulate and adjust air distribution systems, water distribution systems, equipment and apparatus connected there to conform to capacities indicated on the drawings. The Test Company should have past experience in this type of work and has satisfactorily tested and adjusted at least three systems of comparable types and sizes. The testing company will not be accepted if it has any affiliations with Contractors or manufacturers. Testing company should be certified by AABC, NEBB or approved equal. Qualified companies that are not members of AABC or NEBB will also be considered. Personnel shall have a minimum of 5 years of experience in testing and balancing air systems in similar facilities.

5 All equipment shall be commissioned by manufacturer’s Engineers.
14.1.4 Submittals

1 Submit to the Engineer for approval the name of the firm the Contractor proposes to use for work, plus the name, experience and qualifications of the test and Balancing Engineer. The selected firm shall submit to the Engineer:

(a) Detailed Procedures and test sheet forms.
(b) Agenda.
(c) Certified test reports signed by test and Balance supervisor. In addition, the Engineer shall certify the report.
(d) Include identification and types of instruments used and their most recent calibration date with submission of final test report.
(e) Include in maintenance manuals, copies of certified test reports.

14.1.5 Job Conditions

1 Don't proceed with testing, adjusting and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed and the system has started-up. Start-up shall include the following:

(a) All equipment operable in safe and normal condition.
(b) Temperature/Humidity control systems installed complete and operable.
(c) Proper thermal overload protection in place for electrical equipment.
   (i) Final filters clean and in place. If conditions warrant, the Contractor shall install temporary media in addition to the final.
   (ii) Duct systems clean of debris.
   (iii) Correct fan rotation.
   (iv) Fire and volume dampers in place and open.
   (v) Coil fins cleaned and combed.
   (vi) Access doors closed and duct and caps in place.
   (vii) All outlets installed and connected
   (viii) Duct systems leakage shall not exceed the rate specified.

14.2 PRODUCT

14.2.1 Instruments

1 Have in possession the required instrumentation to obtain proper measurements. Properly maintain and transport instruments in such a manner as to provide protection against damage due to vibration, impact, moisture or any other condition that may render them inaccurate.
2 Have instruments calibrated within a period of six months prior to starting the project. Maintain proof of calibration with the instrument. Recalibrate instruments upon completion of the work when required by the Engineer to prove reliability.

3 Use only instruments that have the maximum field measuring accuracy and are best suited to the function being measured.

14.2.2 Patching Materials

1 Except as otherwise indicated, use same products as used for installation for patching holes in insulation, ductwork and housing which have been cut or drilled for test purpose including access for testing instruments, attaching jigs and similar purposes.

2 At Engineer's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housing.

3 Refer to other relevant sections of the HVAC installation materials to be used for patching of holes in insulation, ductwork and housing which have been cut or drilled for test purposes.

14.3 EXECUTION

14.3.1 Inspection and Testing on Site

1 Upon completion of the installation, but before insulation and covering are applied, all piping, duct work, and equipment shall be inspected and pressure tested and proved absolutely tight in the presence of the Engineer.

2 The contractor shall notify the Engineer in writing five (5) days before the date after which he will be ready to make such tests on site.

3 All equipment, instruments, facilities, log sheets, test forms, labor, tools etc. required to properly conduct the tests shall be furnished by the Contractor.

4 All tests must be to the satisfaction of the Engineer and approved by him.

5 Equipment and Pipe Pressure Testing: Each system of piping shall be tested after portions of HVAC Work are completed. Any revision made in piping system after installation will subsequently necessitate re-testing of such affected portions of piping systems.

6 Defective materials or defects in workmanship that develop during tests shall be remedied and the system shall be re-tested. The contractor shall be responsible for any damages due to testing.

7 Piping shall be tested in accordance with the American standard code for pressure piping by maintaining the required pressure during the test.
8 Copper piping shall be subject to test pressure of not less than 1 1/2 times the system pressure but in no case less than 28 ATM.

9 Testing shall continue for a sufficient time to satisfy the Engineer that all leaks and defects have been detected and after testing these shall made tight in an approved manner. If necessary, piping shall be taken down and reassembled, as no makeshift method of temporarily repairing leaks, etc. will be permitted. Tests shall normally be carried out for duration of 24-hrs minimum. Equipment or other piping system components with a working pressure below test pressure shall be isolated from the system during testing and then tested to the required working pressure.

10 Duct Leakage Testing: All ductwork shall be field-tested during construction prior to insulation or concealing in masonry, shafts or above false ceiling. Medium-pressure duct systems shall be constructed to mean that air leakage rates shall not exceed maximum 6 cfm/100sq.ft at 1 in.w.g. test pressure or total of 3% of system airflow at the same pressure whichever is less, and shall be visually tested. Test duct lengths shall not be in excess of 30 meters for risers and 45 meters for horizontal ducts. Duct risers and branches shall be individually tested. Each riser and branch shall be isolated from remainder of system by seals, plugs or caps. Risers installed in shafts shall be tested in sections to allow erection of shaft wall and duct insulation. Adequate duct tightness shall be based upon a maximum leakage rate allowable shall be based upon the total operating air volume m3/hr. of section of duct under test. All ductwork if necessary shall be repaired and re-tested to obtain minimum leakage allowed. Tested sections shall be marked with certification sticker and initials of field test inspector. Additional smoke test shall be made if the engineer required it during construction. All tests’ costs shall be borne by the contractor.

11 Electrical Equipment Testing: All electrical equipment shall be cleaned and adjusted on site before application of power.

12 The following tests shall be carried out:

(a) Wire and cable continuity test.

(b) Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 volt megger. The megger reading shall be not less than one meg. ohm.

(c) Earth resistance between conduit system and earth must not exceed half (1/2) ohm.

(d) Phasing out and phase rotation tests.

(e) Operating tests on all protective relays to prove their correct operation before energizing the main equipment.

(f) Any leaks or faults discovered during such test shall be remedied at once by the sub-Contractor at his own expense and the tests repeated until the Engineer is satisfied that the section under tests is sound or not shall be final.
(g) After each test a signed certificate or approval shall be obtained from the Engineer.

14.3.2 Total System Testing, Adjusting and Balancing

1 General Requirements: Give the Engineer seven days notice before conducting the tests and carry out all tests in the presence and to the complete satisfaction of the Engineer.

2 Include for all testing and commissioning, the provision of the necessary instruments and equipment and the supply of supervisory staff and skilled and unskilled labor. Demonstrate the accuracy of the instruments if required. Test after erection of the installations or sections of the installations or plant items to show that they comply with the requirements of the Contract Documents and to the satisfaction of the Engineer. Perform the tests in the presence of the Engineer.

3 Where necessary, test the installations in section to suit building progress. The number or tests required will be at the discretion of the Engineer.

4 Demonstrate to the complete satisfaction of the Engineer that the installation or any portion thereof, which has been set to work, complies with the requirements of the specification.

5 Rectify any defects of workmanship, materials and performance, maladjustments, non-compliance with this specification or other irregularities, which become apparent during the tests, at no additional cost to the Client.

6 After rectification, repeat test, at the Contractor's expense, until the whole is proved free from defects and in complete working order to the complete satisfaction of the Engineer. All systems shall be left sound and correct.

7 The testing company shall visit the job site when fabricated ductwork is delivered and when hanging is in the very early stages and the installation is well along but before any closing-in.

8 That is done to verify to his satisfaction that all fittings, air volume control devices and water regulating, valves are of the proper type or properly fabricated and are installed as per specifications and that he will be able to balance the systems as required herein.

9 The Contractor shall furnish any special fittings or devices in the piping or duct systems as may be required by the testing agency's instrumentation to obtain the required data. Artificial resistance, equal to dirty filters, shall be added to the clean filter bank by partially blanking of the filter face area.

10 Prior to any air volume testing, any furred spaces, chases, shafts, etc. which are to handle air directly without the use of sheet metal ductwork, shall be tested for leakage. First seal or otherwise prevent the leakage of air through cracks or porous materials in these spaces. All voids around piping, conduit, ductwork or
other services, which pierce the construction, shall be caulked airtight. Before making final duct connections and register installations to such spaces, all such openings shall seal off. The testing agency shall provide a source of metered air to apply approximately twice the static pressure, as determined by Engineer to the space. The leakage of air into or out of the space shall be recorded. Leakage shall not exceed 2% of the design air volume to be handled in the shaft or plenum spaces.

11 Air volume at each inlet and outlet shall be adjusted to within 5% of that shown the drawings. All test data shall be recorded.

12 Upon completion of the work submit three copies of the complete test and balancing reports.

13 Permanently mark the setting of all valves, dampers and other adjustment devices in a manner that will allow the settings to be restored. Set and lock any balancing device, which is provided with a memory stop.

14 The performance of all components of equipment shall be tested under all possible variations of loads, flow conditions, temperatures.

15 All testing and or balancing shall be performed in accordance with National Standards for total System Balance (latest edition) as published by the Associated Air Balance Council (AABC).

14.3.3 Functional and Performance Tests

1 Air Systems: Thermostats setting adjustment shall be tested together with air heater and air coolers.

2 The performance of differential pressure switches at filters shall be checked.

3 After adjustments of supply and return air systems are made, the following items shall be rechecked and readjusted if required:

(a) Blower RPM and motor full load amperes.
(b) System static pressures suction and discharge.
(c) System circulated air and outdoor air, DB & WB temperatures.
(d) Air flow pattern shall be tested for freedom from draughts during a heating period, and during a cooling period in the occupied areas by means of an air flow pattern tester.
(e) Room inside conditions (for each room) DB & WB temperatures should be checked and recorded.
(f) The manual switches and the main disconnection switches external to the main air-distribution and extraction equipment shall be tested together with the associated operation and fault lamps.
4 Sound Test: Tests to demonstrate compliance with sound level requirement shall be conducted in selected areas of the buildings. Readings shall be measured in decibels on the "A" scale of an approved sound level meter.

5 Readings shall set for the total random sound level of the selected area with the system in operation, as compared to total background sound level with the system not in operation.

6 If sound levels are above the specified levels, adjustments shall be made to bring the sound level within the range. If this cannot be done with the equipment as installed, recommendation shall be made to correct the sound level to within the specified range.

7 Sound level readings shall be taken at air diffusers, grilles, or registers, approximately 1.5 meters above the floor, on a line approximately 45 degrees to the center of diffusers, grilles or registers.

14.3.4 Reliability Test

1 After satisfactory completion of total systems balance, the Contractor shall be responsible for running reliability tests for all plant and equipment.

2 During the reliability tests, the independent balancing and testing company will provide spot check readings as requested by the Engineer and sufficient additional readings to confirm that system balance is being maintained.

3 The reliability tests shall be made under the full responsibility of the Contractor, and he shall provide full time skilled operators for running the plant during the whole test period.

4 Each reliability test shall last for a period of 31 consecutive days during which time the whole of the plant under test shall operate continuously without adjustment or repair to the satisfaction of the Engineer. In the event of any repair or adjustment having to be made other than the normal running adjustment, the test shall be void and the installation shall be re-tested after the readjustments or repairs have been completed. A test shall not be void due to circumstances outside the control of the contractor.

5 The whole reliability tests of the refrigeration and cooling plants shall take place during the period between 30th May and 1st September and

6 All log sheets for recording the test results shall be prepared by the Contractor and approved by the Engineer.

7 Daily Log Sheets duly filled in shall be submitted to the Engineer the following day for review and approval.
14.3.5 Cleaning and Adjusting

1 Temporary filters shall be provided for all fans that are operated during construction and new filters shall be installed after all construction dirt has been removed from the building, the ducts, plenums and casings and other items specified hereinbefore have been vacuum cleaned. It shall be the responsibility of the Contractor to maintain the system in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and dampers and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.
15. BUILDING MANAGEMENT SYSTEM

15.1 GENERAL

1 The work to be carried out under this section shall comprise the supply, installation, testing, commissioning and setting to work of all items that are necessary for a complete BMS as per specifications and drawings. Contractor shall develop of a comprehensive Building Automation System including, workstations, DDCs, gateways, protocol converters, Networking Communications etc.

2 The BMS system shall be developed, installed and commissioned by a specialist subcontractor.

15.1.1 Related Documents

1 BMS riser diagrams, BMS BOQs, related MEP drawings, specifications, BOQ and BMS I/O schedules.

15.1.2 Scope of Works

1 Scope of work shall includes Supply, install, testing and commissioning of all BMS equipment (hardware and software) to have complete operational BMS including but not limited to:

(a) Two Redundant hot standby Servers to provide control, supervisory and monitoring functions over the BMS, to interface workstations and peripheral devices such as printers, loggers and data storage devices, etc. Protocol converters to convert different protocols such as mod-bus to operational protocol such as (LON) or (Bacnet), DDCs and Gateways.

(b) BMS network linking between different BMS devices up to gateways.

(c) All necessary hardware and software to enable the BMS to function in accordance with the requirements of the specification.

(d) Provision of spare parts.

(e) Supply of test and measuring equipment.

(f) The contractor shall be responsible for the coordination with the other subcontractors such as the HVAC, electrical and mechanical as required to resolve all necessary interface issues.

(g) The contractor is fully responsible to provide a complete BMS system including all requirements for integration between all systems (HVAC, Electrical, Mechanical, etc.) as per contract requirements.

(h) The supplied BMS shall control and monitor the system as indicated on Input/Output data point schedules.

(i) All sensors, actuators and field devices related to the electromechanical systems are out of this scope of work and shall be covered in the scope of work of the related systems.
15.1.3 Applicable Codes and Standards

1. The BMS, complying with the latest international interoperability standards, shall be installed to cover all controls as required by control point schedules, schematic diagrams and as called for in the specifications of equipment.

2. The standard and codes applicable to only a portion of the work specified in this section are referenced in the relevant parts or clauses. Standards and codes, which are generally applicable to the work of this section, are listed below:


5. The alarm management system shall comply with the requirements of UL864 Category UOJZ and the system shall be so listed.


7. The relevant ITU-R standards.

8. Applicable IEC requirements standards pertaining to system and wiring.


10. BOCA National building Code.

11. ISO/IEC: 15504 Level 3 or higher (SPICE 2.0 Software Process Improvement and Capability Determination).

12. American Software Engineering Institute-Capability Maturity Model SEICMM Level 3 or higher.

13. The BMS operating software shall be in compliant with ISO 9001 environment.

14. The BMS system shall be using appropriate hardware listed by underwriter’s laboratories INC (ULI) for use in Critical process (category QVAX), Requirements of UL 50 and UL 486A etc. or equivalent codes.

15. AMCA 500 for test methods.

16. ANSI 125 flanged connections.

17. ASME MC85.1 Terminology of automatic control.

18. IEC 529 classification of degrees of protection.

19. ISO 7498 Open system interconnect protocol.
20 NEMA EMCI Energy management system Definition.

21 Equal codes and standard could be accepted, which should be listed in detail as an alternative. Such alternative standards shall be indicated in detail together with their equivalent IEC, ITU-R, NFPA and UL. A copy of the approved alternative standard shall be available for submittal upon request, free of charge.

15.1.4 Related Sections

1 The following are the related systems, for specific requirement of every system, refer to related schedules and drawings in BMS system documents and related systems documents and drawings:

(a) Mechanical Systems
(b) HVAC Systems
(c) Electrical Systems
(d) Fire Alarm system
(e) Public address system
(f) Security systems (CCTV, ACS)
(g) Elevators, Escalators and Moving Walks.

15.1.5 Submittals

1 Contractor shall submit the following in accordance with Conditions of the Contract and Division-1 Specification Sections:

2 General: Contractor shall submit the necessary complete sets of documentation indicating type, size, rating, style, catalog number, Manufacturers names, photographs and/or catalog data sheets for all items to ensure compliance with Specifications. This documentation shall be subject to the approval of the Engineer and no equipment shall be ordered without his approval for all equipment and devices, which are shown on documents (drawings, BOQ, etc). Any document submitted by the contractor during the tender stage shall not be considered as technical submittal, it shall be used only to approve the manufacture name.

3 Technical Submittal: Technical submittal shall include the following:

(a) Complete point by point comply sheet with highlighted cross reference on related data sheets, indicating deviations – if any – reasons for such deviations, also indicate any extra features / specifications.

(b) Manufacturer's technical product data sheets, including quantities and specifications of every module, specification of every device, every cable type, system component, quantities, software and installations for each unit of equipment. Pin to pin riser diagram showing all system components and interconnection between the system and all other related systems.
(c) Planes indicating exact location of system components. Provide calculations to support the traffic of the network, required storage capacity, required number of DDCs, gateways.

(d) Complete sequence of operations and functions of the system.

(e) Contractor shall submit a list of the Manufacturer's authorized, local representative responsible for installation coordination and service, pre-qualification for the system provider and installer.

(f) System graphics indicating monitored systems, data (connected and calculated) point addresses and operator notations.

(g) System configuration showing peripheral devices, batteries, power supplies, diagrams and interconnections.

(h) Written description of sequence of operation.

(i) Software description of sequence of operation.

(j) Software licenses

(k) Complete description and data including related standards for all system components.

(l) Test Reports

4 Shop Drawings: Provide shop drawings showing equipment and device locations and connection including riser diagrams. Shop drawings shall include, but not limited to, the following:

5 Complete pin to pin one-line riser diagram(s) showing all approved equipment, size, type and number of all conductors, interconnection between the system and all other related systems.

6 Installation details for raceways, racks and all the other components of the system. Installation details drawings shall show all accessories used in installation such as back boxes, glands, washers..etc. Drawings shall indicate exact location of every single component of the system in coordination with all other systems (Electromechanical, Arch., and Civil).

7 Submitted shop drawings must include signature of all involved engineers representing different disciplines (Electromechanical, etc.) to confirm their approval of such locations installations and coordination.

8 Each control device labeled with setting or adjustable range of control.

9 Details of control panels, including controls, instruments and labeling.

10 Schedule for every device data points, including connected control unit and input device.

11 Commissioning, Testing Procedures and Testing Results: Submit testing and commissioning procedures including required test equipment for the following: Passive cabling, Active equipment, its traffic and performance
Close out Documents: Required documents shall include but not limited to the following:

As built drawings: During the construction of the system, the Contractor shall put in writing all his remarks, during the progress of work, concerning any suggested alterations from the shop drawings in wiring routes, locations of equipment or devices which arise from coordination between the system and other activities.

No execution of alterations shall be allowed before receiving written approval from the Engineer.

All alterations shall be registered and filled by the Contractor and extra copies shall be submitted to the involved parties (Engineer, Project Manager, Site, etc.)

A complete as-built draft set of Drawings and equipment schedules shall be prepared fifteen (15) days after completion of work for approval of the Engineer. The draft as-built shall include all previously approved alterations. Final originals and copies of as-built Drawings shall be submitted in accordance with Division-1, Section 01300 "Submittals".

As built drawings shall include; Planes indicating the exact location of every single component of the system in coordination with the other systems, As built (up dated) pin to pin connection riser diagram indicating type, model, part number of every used unit, device …etc., As built rack/s configuration and connection diagram, as built schedules.

Operation and maintenance manuals including; Up dated data sheets for use equipments, operation instructions, programming procedures Electronic circuits for every device and equipment, troubleshooting repair guide, required spare parts list for 5 years of operation data, circuit diagram

15.1.6 Quality Assurance

Manufacturer Qualifications: Manufacturing firms of the system shall be regularly engaged in manufacturing of same systems and whose products have been in satisfactory service in similar projects for not less than 5 years.

Installer Qualifications: Engage an experienced Installer who is a factory-authorized sales and service representative to perform the work of this section.

The Installer firm shall have at least 5 years of successful installation experience of similar systems for similar projects.

Training: Equipment’s manufacturer and his authorized, local representative shall provide, in depth, equipment service and programming on site training to selected Employer’s personnel for two weeks.
15.1.7 Delivery, Storage and Handling

1. Deliver products in factory containers. Store in clean, dry, closed space in original containers according to factory recommendation. Protect products from fumes. Handle very carefully to avoid shocks or damage.

15.1.8 Warranty

1. Written manufacturer’s warranty covering parts and labor for controller failures within a period of 2 years.

2. The BMS shall be free from defects in workmanship and material under normal use and service. During the warranty period and from the date of substantial completion, if the installed equipment is found to be defective in operation, workmanship or materials, replace, repair or adjust the defect at no cost to the Employer, provided that the defect is reported within seven (7) days of failure occurrence. Service shall be provided within 48 hours upon notice from the Employer.

3. Corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

Escrow agreement in consideration of:

1. The client agreeing under the terms of his agreement with the Management contractor to the engagement by the Management contractor of the subcontractor/controls supplier.

The Subcontractor/controls supplier undertakes that:

1. The subcontractor/ supplier will deposit a copy of the source code for all of his software related to the subcontractor/controls supplier with a third party to be nominated by the client.

2. If the subcontractor/controls supplier shall at any time make any change to the source code, he shall immediately deposit a revised copy with the said third party.

3. The subcontractor/ supplier will pay all cost and charges including those of the said third party incurred in connection with this ESCROW Agreement.

4. In the event that the subcontractor/ supplier or his appointed agent cease to be in the business of maintaining the program product the Client may invoke this ESCROW Agreement to obtain access to the source code and supplementary documentation which is held in ESCROW.

5. In the event that the subcontractor/ supplier or his appointed agent default or fail to undertake maintenance of the program product the Client may invoke this
ESCROW Agreement to obtain access to the source code and supplementary documentation which is held in ESCROW.

15.1.9 Spare parts:

1. Provide a detailed list of spare parts used in the system. (Details shall include technical specifications for the parts, suppliers and compatibility matrix etc.)

2. The contractor shall submit a list of recommended spare parts for three years of operation.

3. The recommended spare parts shall not be less than 10% of the installed quantity rounded to the next figure.

4. ACTION SUBMITTALS

   (a) Product Data: For each control device indicated.

   (b) Shop Drawings:

      (i) Schematic flow diagrams.

      (ii) Power, signal, and control wiring diagrams.

      (iii) Details of control panel faces.

      (iv) Damper schedule.

      (v) Valve schedule.

      (vi) DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.

      (vii) Control System Software: Schematic diagrams, written descriptions, and points list.

5. Informational Submittals

   (a) Field quality-control test reports.

6. Closeout Submittals

   (a) Operation and maintenance data.

   (b) Software and firmware operational documentation.

7. Quality Assurance

   (a) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
15.2 PRODUCTS

15.2.1 General Specifications for the Building Management System

1 A Building Management System (BMS) shall be supplied, configured and commissioned by original manufacturer’s representative of partner.

2 The BMS Specialist is to tender for:
   (a) The complete design, supply, configuration, documentation and commissioning of the BMS including all hardware, software and supply peripheral devices not included in MEP systems scope of work.
   (b) Controls wiring including the conduit and Trunking.
   (c) The system offered shall be completely modular in structure and freely expandable at any stage. Each level of the system shall operate independently of the next level up.
   (d) The system runs on Microsoft® Windows® allowing the user to make full use of the features provided with these operating systems. System supports standard LAN communication on Ethernet® or fiber optics using TCP/IP and standard network equipment. Field bus communication features the open BACnet or LON technology. Only one technology shall be used in the system, end to end.
   (e) DDCs and field devices shall be connected to BMS server through LAN (TCP/IP).

15.2.2 System Description

1 The building management system shall support monitoring for all the system activities and function while the control and adjustment of parameter is prohibited for the operator.

2 The operator will be allowed to access graphic and monitor system operation and measurements, generate log and reports and receive alarms.

3 The system shall allow central control and / or monitoring, of building services including HVAC, Mechanical, plumbing, electrical system, lighting, security and access control, fire alarm system, CCTV system, public address system, etc. as per attached BMS schedules.

4 The BMS shall consist of hardware dual servers in hot standby configuration located at Main IDF room in addition to the GUI Workstations and printers located at the BMS Room. The system shall also include protocol converter to integrate various systems.

5 The BMS shall be hierarchical in structure; each level shall be capable of functioning autonomously and shall be operated independently.

6 Control and management level, Automation level and field devices level.
7 Data and programs should be stored centrally on a file server. User-specific information such as passwords, access rights etc. shall be administered centrally. The file server also shall facilitate and accelerate the handling of software updates and the modification of project data. The consistent, central archiving of alarms, historical data, log-data etc. shall provide a comprehensive overview of the system.

8 The BMS management station software shall run on server, standard PCs or notebook computers without additional hardware.

15.2.3 Scope of Supply

1 BMS system scope of supply includes all items included in this specification. Scope includes but is not limited to the following:

(a) BMS servers, stations and printers
(b) BMS Software and Graphical Human machine interface.
(c) Gateways
(d) DDCs
(e) Protocol converters
(f) Control cables and accessories.
(g) Any other required hardware, software to make the system work and not included in related electromechanical system scope of work
(h) All other items required for full functional system as per specification

15.2.4 Essential Functions of BMS System

1 Following is the description of functions required for Integrated Building Management System by a specialist manufacturer.

(a) Centralized operation of the project
(b) Dynamic Graphic details of the project
(c) Alarms and reports.
(d) Trends (Ex. Sensor Graphs) and Events.
(e) Control Optimization of all connected electrical and mechanical equipments except FA & FF systems
(f) Energy optimization for the building Services.
(g) Maintenance time reminder functions to ensure that system maintenance requirements are annunciated when needed
(h) Event / Exception storage.
(i) Prevention of unauthorized or unwanted access
(j) Possibility of remote operation via LAN/WAN and Internet.
(k) Automatic alarm reporting

15.2.5 The Management Level:

1 The head-end management and operation of the plant shall include process visualization, data analysis, and exchange of data with 3rd parties. At the management level, it shall be possible for communication to flow in all directions, across networks and via direct connections.

2 Latest PC with BMS Software, for Human Machine Interface BMSed on the Microsoft Windows Environment. The features of the system should include dynamic graphical user interfaces, data acquisition and logging alarm and system exception handling.

15.2.6 The Automation Level:

1 This level at which the actual processing takes place BMSed on the logic written on the DDC. The processes shall be carried out at the DDC controllers for stand-alone control of all plant.

2 All Management functions and event related communications should be carried out at the DDC level.

3 The Direct Digital Control and Interlock system for the control loops shall comprise microprocessor BMSed controllers along with the necessary input and output terminals integrated to the controllers. All the field devices shall be connected to the respective input and output terminals.

4 The DDC unit must be programmable and stand-alone and ensure a fully automatic operation of the electrical and mechanical plant. The units must be fitted with a 32-bit microprocessor with a maximum cycle time of 1s. Controller with 8 bit or 16 bit Micro-processor is not acceptable at all. The controller should be in-built with LEDs for Network monitoring, power and watchdog.

5 The programming language must be self-explanatory block functions. The programmability shall be easy for creation and modification of custom control strategies and easy for duplication of controller data BMS’s for equipment containing similar or identical control strategies.

6 DDC shall have 25% spare points for future extension.

15.2.7 Points Schedules:

1 The BMS tenderer shall provide a points schedule showing each proposed connected point to the system according to input/output contract schedules. The points shall be arranged as schedules showing the points allocated on a plant-by-plant BMS is, the controller specification(s) selected, I/O capacity supplied and the spare I/O available for future use. Any points schedule supplied with this specification shall be considered as supporting information only and the contractor is fully responsible to provide a complete system including all
requirements for integration between all systems such as HVAC, Fire Alarm, Fire Fighting, etc. The BMS specialist shall be responsible for ensuring the correct allocation of points required for meeting the performance specification.

15.2.8 MAIN BMS Software applications

1. The main BMS applications shall include:

   a. System Configuration: General set-up of BMS workstation and its applications.

   b. Realistic graphics, for fast and targeted system monitoring and operation.

   c. Trend Viewer: Historical and real-time processing of data, for convenient analysis of historical data and trends, to optimize operation.

   d. Alarm Viewer: A detailed overall view of the alarms for fast location and elimination of faults.

   e. Alarm Router: Flexible alarm routing to printers, fax, mobile phones.

   f. Log Viewer: All alarms, faults and user activities are logged and can be displayed as required for further analyses.

   g. Time Scheduler: Central programming of all time- controller building services functions.

   h. Object Viewer: An efficient tool to navigate through the building control system.

   i. Operator Terminal: Alphanumeric operation of all subsystems.

2. Object linking and embedding for process control (OPC) for connectivity to third party OPC compliant software/devices.


4. Dynamic data exchange (DDE).

5. Dispatch of a single time schedule to all programmable nodes.

6. The system will have a topology BMSed on freely programmable system controllers so that a broad variety of 3rd party systems can also integrated.

7. All 3rd party-systems integrated via the system controllers shall interact between each other and of course also exchange data with their own subsystems.

8. The BMS shall support communication with 3rd party systems.

9. The controllers shall be of the microprocessor type for the DDC regulation (Direct Digital Control)

10. They shall be able to communicate with one another through a bus standard system selected according to HVAC system selected protocol. (LON Mark on LON bus or Bacnet).
In case of devices with other protocols, a protocol converter shall be used.

Communication must also be possible with other devices of any compatible brand, and with the supervision system. At the field bus, the controllers must be able to share the signals with any device physically connected with one of them.

From the BMS servers / work stations it shall be possible to modify each pre-defined controller's program, but the single controller shall be fully independent (stand-alone mode).

15.2.9 BMS Software Configuration

At a minimum, the HMI shall permit the operator to perform the following tasks, with proper password access:

(a) Create, delete, upload, or modify control strategies.
(b) Add/delete objects to the system.
(c) Tune control loops through the adjustment of control loop parameters.
(d) Enable or disable systems
(e) Generate text file reports to a networked printer.
(f) Select points to be alarm-able and define the alarm state.
(g) Configure alarms to be sent to Microsoft windows mail client
(h) Select points to be trended over a period of time and initiate the recording of values automatically.
(i) Provide different levels of security to every object in the HMI dataBMSe
(j) Modify and create users with passwords and access levels and also be able to use currently logged on users and passwords

15.2.10 Bms Ic Configuration And Performance Equirements

The DDC units must be programmable and stand-alone (microprocessors for each Panel) and ensure a fully automatic operation of the electrical and mechanical plant, which must allow for a rational operation and fast system response. The units must be fitted with a powerful processor with high processing speed, a suitably sized memory capacity and a modular graphic programming language for the project specific application programs.

For the communication between the DDC modules, a bus-system must be used which provides a peer-to-peer communication with fast and secure data transmission. The communication between the individual DDC units must stay fully operational even when the upper levels and/or individual DDC units fail.

Functions: Standard BMSic functions resident in each programmable plant controller shall include the following (to be used only for monitoring only): BMSic functions (software modules) which can be combined by means of application programs to form any monitoring strategy required.
15.2.11 DDC

1. DDC shall have the following functions:

(a) Free selection of signals range.

(b) Free allocation of access protection in accordance with operating priorities.

(c) Free definition of manual override priorities (software) from operator terminal and/or management station.

(d) Graphic documentation of application programs in function plans (structure diagrams). The signal paths must be clearly identifiable for operators without special programming knowledge.

(e) A self-monitoring of the processor and self-test or correct functioning of the functions must be automatic.

(f) If for any reason the communication between the control DDC is interrupted by wire breaks/disconnection etc., then each control module shall continue to function autonomously, to provide all functions including time-of-day BMSed routines.

(g) Each DDC should have an Ethernet inbuilt providing the capability to integrate directly with the LAN. DDCs for HVAC shall be included in HAVC scope of work; DDCs for other electromechanical systems are included in BMS scope of work.

(h) Field devices – if any – shall be capable of two-way communication with DDC to send all required collected data and receive control signals if any.

(i) The connection of the DDC units to the data bus must be provided as standard local operation. Each DDC unit, communication and control unit shall be connectable to the system gateway via the data bus (LON or BACnet).

(j) Gateways shall be in the related SER “Satellite equipment room”. Required network (RS 485 or else) from the location of any device up to the related gateway is included in the scope of BMS contractor.

(k) The DDC controllers shall be supplied complete with the means of communicating with other controllers in the building without the necessity of adding components later on.

(l) Data must be kept even in the event of power failure. Power failures and peak loads must not cause data loss. The controller shall store its operating system in EPROM to ensure integrity during a power failure (min. 10 years). The controller shall store its time and data in EPROM to ensure integrity during a power failure (min. 30 days). Permanent self-monitoring of the system must be ensured by integrated test and service functions. All controllers shall have a software override facility, stored in the built in EPROM. The DDC shall be available in several modules of differing point size, all models shall be fully compatible in size and operation to provide for further expansion. It shall also be possible to plug in controllers with a larger point capacity into the lower capacity BMSe up to the maximum module size. Thereafter it shall be possible to arrange controllers adjacent...
to one another, the arrangement automatically making any necessary bus connections between the controllers.

(m) All controllers, power supplies and relays shall be mounted in enclosures.

(n) Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.

(o) Enclosures shall have hinged, locking doors.

(p) Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate.

(q) Laminated plastic shall be 1/8” thick sized appropriately to make label easy to read

15.2.12 Network Gateway

1 General Scope: Sufficient network system controllers shall be provided to meet the building requirements. Each gateway shall support up to 1500 system points. (every gateway shall have adequate capacity to handle related points)

2 It shall provide an interface between DDCs, LCPs, protocol converters and the BMS system through the project LAN

3 Encompassed in the above role are the real-time monitoring, data gathering and storage functions which enable the performance of the system and its connected processes to be evaluated, as well as providing earliest warning of detected faults and breakdowns.

4 The system shall include the necessary software and hardware required for communication with the connected systems through the project LAN using TCP/IP protocols.

5 Alarm and Event Reporting: As this function is best described in an overall context which also includes the management level, a complete overview is provided in ‘Alarm Management”.

6 Energy Management Functions: the following blocks shall be available for implementing energy management functions at the system controller level. Optimum start/stop control (adaptive).

7 Duty Cycle Operation.

8 Global Interlocking/Sharing: Blocks shall be available which allow the direct transfer of data between system controllers on the same network on a peer-to-peer BMSis. These are foreseen for global interlocking and sensor sharing purposes.

(a) Network Gateway Ports

(b) Operator Station: For PC BMSed operator station
(c) Interface: RS-232/RS-485

(d) Baud rates: 1200/2400/4800/9600/19200/38400 baud.

(e) Connection: RJ-45 direct connect to LAN

(f) Serial Printer: Directly connected within 15 meter, or remotely via external modem.

(g) Parallel Printer: Directly connect within 5 meters. PC parallel port printout.

(h) Connection Of Peripheral Devices: The signal adaptation and the transmission of signals between the peripheral devices (such as sensors, control devices, starters etc.) and the DDC system shall be achieved via terminal module carriers and plug in terminal modules. In this case one terminal module is to be used for each point. The connection of more than one point of the same type to one module is unacceptable.

(i) The peripheral devices shall be connected to the terminal module carriers by screw terminals. The connection to the DDC system from the terminal module carriers must be by plug-in ribbon cables.

(j) For a direct (independent of DDC unit) override control (safety interlocks) of the connected inputs and outputs (control devices etc.) via external voltage-free contacts, additional connection terminals must be provided for the output modules.

(k) Individually plug-in terminal modules are required for each data point, so that the possibility of isolating the plant from the system facilitates the maintenance and service work and ensures that plant can be expanded or modified depending on the demand.

(l) Where interfacing relays are required between the control manufacturer’s equipment and other items, the control supplier shall include the cost of these items in his quotation

(m) The terminal modules shall meet the following requirements:

(n) Electrical separation between the electrical and mechanical plant and the DDC System.


(p) Permanent display of operating stages by way of integrated LED.

(q) Clear labeling data points.

(r) Possibility of separating the electrical and mechanical power from the DDC system by removing individual terminal modules.

(s) Connection of all active and passive standard signals (0-10V, 4-20 mA, etc). different standards could be in different modules as per function requirement.

(t) Outputs to all standard control devices (modulating, reversible etc.).

(u) All output terminal modules shall provide local status indication for both digital and analogue functions as per function requirement.
(v) Terminal modules shall have the capability of including manual override switches on them to facilitate commissioning. Testing and fault finding and enable them to be operated independently of the DDC system.

15.2.13 Protocol converter

1 A protocol converter is communication interface between 2 different protocols, It allows dissimilar devices to communicate with each other without need for any changes in devices itself

2 It shall be microprocessor BMSed and power by embedded operating system ease to be configured using GUI program

3 Converter is used to convert all used protocols in all other disciplines to the selected standard protocol of the BMS System as per project requirements

4 Operator Station : For PC BMSed operator station

5 Connection: RJ-45 direct connect to LAN

15.2.14 Local Operator Terminals

1 A local operator terminal shall be provided to provide menu-driven displays using the English language, enabling the operator to identify and read all set point values, sensed values, calculated values and status conditions throughout the control system. The same terminals shall enable the operator with suitable access authority - to change set points, controller parameters, timetables and output statuses.

2 Any alarm condition occurring at any control module shall be notified to all local operator terminals on the same bus, to give visual and audible indication of the existence of an alarm, which may be subsequently identified and acknowledged.

3 Each local operator terminal shall provide three levels of access to all functions and parameters, all of these functions and parameters shall be individually allocable for a particular operating level when the functions are programmed into the main plant controllers.

4 Operator terminal should have three operating levels with a different password for each level.

15.2.15 Supervisory and Management Stations

1 A Central Console, Located in the control room shall function as the primary means of overall system control and monitoring. The following components shall be mounted on the console:

2 Redundant servers (latest version of brand names at the time of purchase).
3 PC BMSed network computer. (Branded Workstation) with 19” LCD (TFT). Specifications for these workstations shall be according to a stamped letter from the Manufacturer with the following minimum requirements.

4 Management stations shall be industry standard PC’s each with a minimum specification or latest version at the time of purchase as follows:

- **Processor:** 3.2 GHz Pentium IV processor with 800 MHz Front Side Bus
- **Memory:** 4GB main memory minimum
- **Cash:** 4MB
- **DVD RW**
- **Hard Disk:** 320 GB or larger 7400 RPM
- **Comm. Port:** One Interface Port to system controller, network card.
- **Monitor:** VGA for higher color graphic displays (640 x 480 pixel resolution)
- **Graphics Card:** 512 MB SGRAM video graphics
- **Mouse:** Microsoft bus mouse
- **Printer:** Parallel port configured as LPT1

5 Full duplex Creative Sound Blaster. 56 Kbps modem.

6 Six USB ports.

7 Two UART 16550-compatible serial ports and one enhanced parallel port.

8 PS/2 full multimedia keyboard.

9 Preloaded Windows 7 or the later version with original documentation.

10 System software and license agreement for all applicable software.

11 Note that the workstation configuration shall be the latest available in the market at the time of material submission.

12 Two types of printers for receiving logging and alarm only:
   (a) Dot matrix printer
   (b) A4 laser printer

13 Desk mounted direct line telephone for communications with the life safety system personnel.
   (a) System Management and Operation Features: The management station
software shall support the following system management and operation features:

(b) User Definable Operator Classes: Passwords shall be allocated to one or more user-definable operator classes. Access to data-points and function blocks shall be petitioned according to discipline e.g., HVAC, electrical, etc. up to 12 operator classes shall be supported.

(c) Pull Down Menus: Pull down menus shall show the possible options under the selected main menu item which shall be available to the operator according to the respective password level with which he logs in.

(d) On-line Help: Help shall be displayed dynamically in a window whilst being on-line in any chosen menu item. The displayed text shall be “context-sensitive”, i.e., relevant to the function or menu item which is currently selected, and describes the consequences of involving the associated command.

(e) System Wide Message Broadcast: Users shall be able to send messages to other users in management stations directly connected to the system controller network. Messages shall only be received at predetermined stations.

(f) Reporting Package: The reporting package shall provide the actual status of data points or functions which the user can specify for a selected system controller from the range of options listed below. All reports shall be accessible from the report menu. The reporting package shall include but not limited to the following:

(g) Report by Name: Shall allow information to be grouped by name (e.g. FLOW TEMP) for all flow temperatures.

(h) Report by Type: Shall allow information to be grouped by block (e.g. all digital output blocks).

(i) Report by Address: Shall allow information to be grouped by data point location within the system configuration (i.e. module physical address).

(j) Report by Status: Shall list all points, which are in a specified status (e.g. in alarm, under manual control etc.).

(k) Report by Class of Alarm: Shall allow information to be grouped by class of alarm.

(l) Report by Value: shall group information by value as greater than, equal to, or less than (e.g. all humidified areas less than 40%). In each case above, the user may “wild card” the specified entry to generically group data points or functions into a single report. More specific report options shall include:

(m) Control Block Report: Shall display block parameters and dynamic values for a specified source block and the subsequent blocks in the program chain? The user can specify the number of program branching levels, which are to be listed.

(n) Alarm Log Report: Shall display contents of the alarm log file resident on the PC hard disk (see “Alarm Management”).
(o) History Report:
   (i) Shall display the accumulated values and statues in a specified history block, in chart or graphical format (see “Trend/History Package”).

(p) Custom Report:
   (i) Shall display actual values of pre-selected data points and functions together with user texts, which are completely configured and freely formatted at the generation stage as templates.
   (ii) Unlike the other reports described above, this report can also be generated automatically on an event-driven BMSis for output to hard-disk, printer or screen.
   (iii) The data points and functions, which are configured for this type of report, do not need to be resident in the same system controller.

15.2.16 Printers

1 Provide two printers for Logging, alarm and one A4 printer.

2 The dot matrix printers shall be heavy-duty type with 132 characters per line. Printers shall be provided with alarm tone sound and to be latest version.

3 The output typed copy shall be paper and shall be suitable for easy insertion into ring binder with calendar date and time of day automatically typed at beginning of each log.

4 The alarm printer supplied with the system shall operate when messages and alarms fall due irrespective of the network computer if off-line. The printer shall be used for the recording of information associated with system logs requested by the operator, binary off-normal of analog indication, and operator changes introduced through the keyboard. A descriptive format shall be used, for ready interpretation by the operator without use of an index or other reference.

5 The alarm printer shall utilize two-color printing or an alternative approved means to distinguish between alarm conditions and return to normal

15.2.17 Graphical Operation

1 Graphical editor shall import CAD drawings of the project and implement all the data on it.

2 Graphic screens shall be developed using any drawing package capable of generating and importing a GIF, BMP, DWG, DXF, or JPG file format. In addition to, or in lieu of a graphic background, the HMI shall support the use of scanned pictures.

3 Graphic screens shall contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML, or XML document links, schedule objects, hyperlinks to other URL’s, and links to other graphic screens.
4 The graphics editor shall provide the following facilities, which enable customized graphics to be created by the user for the operational purposes.

5 Standard HVAC symbol library to assist rapid graphic generation. “Cut, Copy and paste” feature for relocating a generated graphic portion within the same graphic or transferring to another graphic.

6 “Graphical doorways” which enable the operator to rapidly (typically in 0.2 seconds) step hierarchically from one graphic to another by clicking the mouse. This shall allow the building or site to be broken down into several graphics following a treeing method; the user is thus guided in his movements between graphics along branches as defined by the graphical doorways.

(a) Password levels assigned to each of the doorways shall be implemented to hide any unauthorized or non-relevant pathways from the operators view.

(b) Oversized graphics shall be supported to provide the user with an uncluttered view of detailed graphics, which are larger than the physical screen size as given below:

(i) Min. width of graphic: 30 x screen width.

(ii) Min. height of graphic: 40 x screen height.

1) Pan and scroll movements controlled by the mouse enable the user to view any portion of the oversized graphic. Such movements shall be smooth to the eye without any visible “Jitters” or jumping effect.

2) Scroll bars shall show which part of the oversized graphic is being displayed, employing “sliding buttons” which indicate the relative vertical and horizontal shift from the graphic edges. The operator can instantly shift the viewed portion by “sliding” the buttons along the bars with the mouse. The scroll bars can be activated and deactivated at any time.

3) Icons shall be provided to simplify operation and allow special functions (later described) to be activated using the mouse only, thereby further reducing keyboard strokes.

4) An icon shall be represented by a corresponding graphics symbol for this purpose.

5) Such graphics shall be displayed by activating a slide icon, and could consist of high-resolution drawings, illustrations and visual explanations e.g. details of “on-line” alarm response or maintenance data and instructions. Close examination of detailed drawings shall be facilitated by the ability to zoom in on particular areas of interest, whereby up to two levels of enlargement can be invoked. This zooming feature shall only be applicable to special slides and cannot be activated in the usual dynamic graphic displays.

6) Jump tags shall enable the user to “jump” to a pre-defined display area by activating a corresponding jump tag icon.
7) Pop-up windows shall be employed to provide additional information on the screen about the selected item (point name, address and text description), as well for displaying the manual command options. In both cases the appropriate window “pop-up”, depending on which mouse button is clicked, otherwise these displays shall be normally suppressed.

8) Points within designated fields located in the graphics.

9) Digital statuses of data points can additionally be displayed by the color, shape and mode (whether flashing or not) of their associated graphic symbols.

10) Analogue and totalized values can additionally be displayed graphically using thermometer symbols such that the length of the associated thermometer column is varied dynamically in accordance with the analogue input.

11) Manual control menus shall allow the operator to turn points on and off, start and stop points, adjust set points, release points to automatic control etc.

12) These menus shall be displayed in “pop-in window” which appear when the selected item is clicked with the mouse.

13) Trend icons shall invoke trend displays directly from the graphic of the associated plant equipment (see “Trend/History Package”).

14) The Graphical Plans for the project buildings shall be displayed indicating each device monitored or controlled via the BMS, Setting points for devices shall be configured by double clicking on the device required to be configured.

15.2.18 Alarm Management

1 General: Alarm monitoring shall be performed at the system controller level BMSed on alarm blocks, which monitor the associated inputs. These shall be defined and attached to the selected physical and calculated points to be monitored, at the engineering stage.

2 Alarms, which are detected, shall be subsequently reported to a corresponding device as defined in the alarm device block, where they shall be presented to the user for subsequent action to be taken.

3 Monitoring: Alarms can be monitored for any physical or calculated point in the system BMSed on:

(a) Digital change of state.
(b) Analogue high and low limits (sliding or non-sliding).
(c) Command/feedback mismatch.
(d) Counter Totalization limit.
(e) Conditional case.
4 Reporting: When activated, alarm device blocks shall direct the associated user defined message to one or more of the following devices directly or indirectly to the system controller:

(a) Local printer(s) connected directly to the system controller.
(b) Directly connected management station(s).
(c) Other management station(s) on system controller network.

5 Alarm device assignments shall be collective for all alarms belonging to the same alarm class (e.g. “Alarm, Categories” below). In the case of alarms being reported to a management station, the screen, printer or hard disk can be specified as the destination.

6 Suppression: Alarm suppression shall be programmable such that events (e.g. plant shutdown) can be used to inhibit or enable the reporting of alarms. Any necessary time delays can also be taken into consideration at the programming stage.

7 Verification delays can be defined for command/feedback points to suppress invalid alarms where the feedback does not normally respond immediately (e.g. from flow switches).

8 Alarm Categories: Alarms shall be categorized into different classes e.g. abnormal maintenance, critical etc., for partitioning disciplines and grouping alarms together for routing purposes.

9 Presentation: Alarm messages directed automatically to printers connected to the corresponding system controller or a configured management station can consist of up to 40 characters.

10 Any present unacknowledged alarms shall be identified by whether the screen boundary has changed color. Different colors can be defined to partition alarms for presentation purposes, including whether this should be accompanied by an audible buzzer or not.

11 If a graphic displayed on the screen contains a point, which is in alarm conditions, the symbol associated with that point shall be seen to be flashing in the designated color.

12 Action/Acknowledgment:

(a) Alarms can be acknowledged individually through a Menu command. A pop-up window, which shall be activated by clicking on the flashing symbol indicating the point in alarm. Alternatively jump tags can be implemented to direct the user to graphics, which contain pre-configured alarm tables. In this case the user obtains a status overview of all possible alarms in a given plant or building, from which they can subsequently be acknowledged individually.

(b) Further measures to be taken by the user in the event of incoming alarms
can be configured in help screens, which are accessed via slide icons selectable from within the above alarm tables. In both cases above, the dynamic alarm display shall only reset when all outstanding alarms have been acknowledged.

(c) Alarms shall be annunciated in any of the following manners as defined by the user:

(i) Screen message text.

(ii) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms BMSed on:
   
   1) Day of week.
   2) Time of day.
   3) Recipient.

(iii) Pagers via paging services that initiate a page on receipt of email message.

(iv) Graphic with flashing alarm object(s).

(v) Printed message, routed directly to a dedicated alarm printer.

(vi) Audio messages.

(d) The following shall be recorded by the OWS HMI software for each alarm (at a minimum):

(i) Time and date.

(ii) Location (building, floor, zone, office number, etc.).

(iii) Equipment (air handler #, access-way, etc.).

(iv) Acknowledge time, date, and user who issued acknowledgement.

(v) Number of occurrences

(e) Alarm actions may be initiated by user defined programmable objects created for that purpose.

(f) Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

(g) A log of all alarms shall be maintained by the OWS HMI and shall be available for review by the user.

(h) Attach a graphic screen, text notes, and/or plant status report, to each alarm, as defined by user.

(i) Repeat/nuisance alarms must have feature to be disabled, and a feature for monitoring disabled alarms.

(j) The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. An alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This
window will notify the operator of new alarms and un-acknowledged alarms.

(k) The dedicated alarm window shall provide user selectable colors for each different priority of alarm.

15.2.19 Data BMS Backup and Storage

1 The BMS Software HMI shall have the ability to automatically backup its data BMSe. The data BMSe shall be backed up BMSed on a user-defined time interval.

2 Shall have the ability to automatically complete full or partial backups; and have the ability to full or partial restore. Partial is defined as only items that have changed in the data BMSe.

3 Copies of the current data BMSe and, at the most recently saved data BMSe shall be stored in the System. The age of the most recently saved data BMSe is dependent on the user-defined data BMSe save interval.

15.2.20 Trend/History Package

1 General: All real-time data relevant for trend and historical purposes shall be in the first instance gathered by the system controllers. The resulting data logs maintained by the system controllers can be requested by the operator at a management station connected to the system controller network for immediate presentation and/or archiving to disk. Archived records can at any time be recalled for presentation in various formats. Their contained data can also be evaluated further using off-the-shelf software packages for customized report generation.

2 Data Logging: The system controller can be configured to gather data from any physical or calculated point in the system.

3 Storage Capacity: A system controller shall have a fixed total amount of memory space, which can store time-and-date stamped samples.

15.2.19 Grounding

1 Connection with clean earthing is a part of the contract and as recommended by the manufacturers.

2 System bonding and grounding including active and passive components, test apparatus and equipment shall be in accordance with International and/or Local Regulations. Provide a Bonding Backbone utilizing bonding conductor of appropriate size that provides direct bonding between field components and equipment rooms. This is part of the grounding and bonding infrastructure, and is independent of equipment or cable.

3 The Contractor shall be responsible for ensuring an approved ground at all newly installed equipment and wiring, and/or insuring proper bonding to any existing facilities.
The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework. All grounds shall consist of appropriately sized copper wire and shall be supplied from an approved building clean earth ground. Grounding must be in accordance with all local codes and practices.

15.2.20 Cables and Wires

1 All required cables and cabling work between gateways, DDC’s, field devices and other devices related to any other system is included. Wiring shall be installed inside UPVC conduits inside concrete / walls, for all other cases, raceways shall be Hot Dip galvanized steel.

2 The cable types and size shall comply with manufacturer’s requirements

3 Special communication shielded/unshielded cables for the system should be used for installation suitable for dry rooms with medium mechanical requirements and also damp and wet locations.

4 This cable shall be capable to handle communication protocols such as LON MARK, Backnet, Modbus and serial RS485

| No. of cores | 2 cores |
| Copper conductor | as per manufacture recommendations |
| Core insulation | LS0H |
| Outer sheath | LS0H |
| Imprint | contain all cable information (Manufacturer, Model, type of sheath, conductor diameter, etc.) |

Should be certified for LS0H propriety as per international standard IEC or equivalent

15.3 EXECUTION

15.3.1 Examination

1 Final locations: determine exact locations of the control cabinets.

2 Verify that conditioned power supply is available to control units and operator stations. Verify that all field end devices are installed before proceeding with installation.

15.3.2 Installation

1 Install equipment as indicated to comply with manufacturer’s written instructions.

2 Install software in control units and operator workstations. Implement all features of programs to specified requirements and appropriate to sequence of operation.
3 Connect and configure equipment and software to achieve the sequence of operation specified.

4 Use raceways provided for other systems for BMS-communication bus wiring and for cabling to the electrical and transport systems. All wiring must be labeled. Repeat this labeling every 10 meters.

15.3.3 Commissioning

1 Manufacturer’s Field Service: Provide the services of a factory-authorized service representative to start control systems.

2 Test and adjust controls and safeties of the main and sub-systems, which include functional tests, integration, interface with the connected systems etc.

3 Replace damaged or malfunctioning controls and equipment.

4 Start, test and adjust control systems.

5 Demonstrate compliance with requirements.

6 Adjust, calibrate and fine tune circuits and equipment to achieve sequence of operation specified.

7 Reliability Tests: Correct deficiencies and retest until are specified requirements are met. All equipment should be installed and fully functional for thirty continuous days (30) without failure.

15.3.4 Cleaning

1 Clean units using materials and methods recommended by manufacturer.

2 Clean finishes to remove dust and dirt.

15.3.5 Demonstration and Training

1 Manufacturer’s Field Services: Provide the services of a factory-authorized service representative to demonstrate and train Employer’s maintenance personnel as specified below.

2 Train Employer’s maintenance personnel (2 persons) on procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventive maintenance.

3 Schedule training with Employer with at least 14 days’ notice.

4 Provide operator training on data display, alarm and status descriptors, requesting data, execution of commands, request logs, administration using running, commissioning and maintaining all engineering service include a minimum of 80 hours’ dedicated instructor time on-site.
15.3.6 Factory Acceptance Testing (Fat):

1 Factory acceptance testing for this system requires the presence of the Employer staff/Engineer at the factory for 5-7 days; therefore ticket, travel, accommodation, and daily allowance for five (5) of the Employer staff/Engineer shall be included in the price of the testing and commissioning item in the BOQ.

2 Control System

(a) Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

(b) Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

3 DDC Equipment

(a) Operator Workstation: PC-BMSed microcomputer with minimum configuration as follows:

(i) Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

(ii) Processor: Intel Pentium 4 MHz.

(iii) Random-Access Memory: 512 MB.

(iv) Graphics: Video adapter, minimum 1600 x 1200 pixels, 64-GB video memory, with TV out.

(v) Monitor: 19 inches (480 mm), LCD color.

(vi) Keyboard: QWERTY, 105 keys in ergonomic shape.

(vii) Hard-Disk Drive: 500 GB.

(viii) CD-ROM Read/Write Drive: 48x24x48.

(ix) Mouse: Three button, optical.

(x) Uninterruptible Power Supply: 2.

(xi) Operating System: Microsoft Windows XP Professional with high-speed Internet access.

(xii) Printer: Color, ink-jet type as follows:

(xiii) Print Head: 4800 x 1200 <Insert value> dpi optimized color resolution.

(xiv) Paper Handling: Minimum of 100 sheets.
(xv) Print Speed: Minimum of 17 ppm in black and 12 ppm in color.
(xvi) Application Software.

4 Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

(a) Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.
(b) Stand-alone mode control functions operate regardless of network status. Functions include the following:
   (i) Global communications.
   (ii) Discrete/digital, analog, and pulse I/O.
   (iii) Monitoring, controlling, or addressing data points.
   (iv) Software applications, scheduling, and alarm processing.
   (v) Testing and developing control algorithms without disrupting field hardware and controlled environment.

(a) Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

(i) Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
(ii) Stand-alone mode control functions operate regardless of network status. Functions include the following:
   1) Global communications.
   2) Discrete/digital, analog, and pulse I/O.
   3) Monitoring, controlling, or addressing data points.
(iii) Local operator interface provides for download from or upload to operator workstation.

5 I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

(a) Binary Inputs: Allow monitoring of on-off signals without external power.
(b) Pulse Accumulation Inputs: Accept up to 10 pulses per second.
(c) Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
(d) Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

(e) Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

(f) Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

(g) Universal I/Os: Provide software selectable binary or analog outputs.

6 Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

(a) Output ripple of 5.0 mV maximum peak to peak.
(b) Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
(c) Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

7 Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

(a) Minimum dielectric strength of 1000 V.
(b) Maximum response time of 10 nanoseconds.
(c) Minimum transverse-mode noise attenuation of 65 dB.
(d) Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

8 Unitary Controllers

(a) Unitized, capable of stand-alone operation with sufficient memory to support its operating system, dataBMSe, and programming requirements, and with sufficient I/O capacity for the application.
(b) Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
(c) Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
(d) Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
9 Analog Controllers

(a) Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

(b) Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.

(c) Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

(d) Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

(e) Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

10 Time Clocks

(a) Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

(b) Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

11 Electronic Sensors

(a) Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

(b) Thermistor Temperature Sensors and Transmitters:

(i) Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.

(ii) Wire: Twisted, shielded-pair cable.

(iii) Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
(iv) Averaging Elements in Ducts: 18 inches (460 mm) long, rigid; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).

(v) Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).

(vi) Room Sensor Cover Construction: Manufacturer's standard locking covers.

(i) Set-Point Adjustment: Concealed

(ii) Thermometer: Exposed.

1) Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

2) Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

(c) RTDs and Transmitters:

(i) Accuracy: Plus or minus 0.2 percent at calibration point.

(ii) Wire: Twisted, shielded-pair cable.

(iii) Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).

(iv) Averaging Elements in Ducts: 24 inches (610 mm) long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.

(v) Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).

(vi) Room Sensor Cover Construction: Manufacturer's standard locking covers.

(vii) Set-Point Adjustment: Concealed.

(viii) Set-Point Indication: Exposed.

(ix) Thermometer: Exposed

Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

(x) Humidity Sensors: Bulk polymer sensor element.

Accuracy: 5 percent full range with linear output.

Room Sensor Range: 20 to 80 percent relative humidity.
Room Sensor Cover Construction: Manufacturer's standard locking covers.

(iii) Set-Point Adjustment: Concealed.

(iv) Set-Point Indication: Exposed.

(v) Thermometer: Exposed.

Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.

Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F (0 to 50 deg C).

Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

(vi) Pressure Transmitters/Transducers:

Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

(i) Accuracy: 2 percent of full scale with repeatability of 0.5 percent.

(ii) Output: 4 to 20 mA.

(iii) Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).

(iv) Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.

Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.

Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

(v) Room Sensor Cover Construction: Manufacturer's standard locking covers.

Set-Point Adjustment: Concealed

Set-Point Indication: Exposed.
Thermometer: Exposed.

(vi) Room sensor accessories include the following:

Insulating BMSes: For sensors located on exterior walls.

Guards: Locking; heavy-duty, transparent plastic; mounted on separate BMSe.

Adjusting Key: As required for calibration and cover screws.

12 Status Sensors

(a) Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

(b) Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.

(c) Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

(d) Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

(e) Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

(f) Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

(g) Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

(h) Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

13 Gas Detection Equipment

(a) Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 ppm.

(b) Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output, for wall mounting.
(c) Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

14 Thermostats

(a) Electric, solid-state, microcomputer-BMSed room thermostat with remote sensor.

(b) Automatic switching from heating to cooling.

(c) Preferential rate control to minimize overshoot and deviation from set point.

(d) Set up for four separate temperatures per day.

(e) Instant override of set point for continuous or timed period from 1 hour to 31 days.

(f) Short-cycle protection.

(g) Programming BMSed on every day of week.

(h) Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.

(i) Battery replacement without program loss.

(j) Thermostat display features include the following:

   (i) Time of day.
   (ii) Actual room temperature.
   (iii) Programmed temperature.
   (iv) Programmed time.
   (v) Duration of timed override.
   (vi) Day of week.
   (vii) System mode indications include "heating," "off," "fan auto," and "fan on."

(k) Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

(l) Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

(m) Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.

(n) Selector Switch: Integral, manual on-off-auto.
(o) Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

(p) Bulbs in water lines with separate wells of same material as bulb.

(q) Bulbs in air ducts with flanges and shields.

(r) Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.

(s) Scale settings and differential settings are clearly visible and adjustable from front of instrument.

(t) On-Off Thermostat: With precision snap switches and with electrical ratings required by application.

(u) Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

(v) Room Thermostat Cover Construction: Manufacturer's standard locking covers.

(w) Set-Point Adjustment: Concealed.

(x) Set-Point Indication: Exposed.

(y) Thermometer: Exposed.

(z) Room thermostat accessories include the following:

(aa) Insulating BMSes: For thermostats located on exterior walls.

(bb) Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate BMSe.

(cc) Adjusting Key: As required for calibration and cover screws.

(dd) Set-Point Adjustment: 1/2-inch- (13-mm-) diameter, adjustment knob.

(ee) Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

(ff) Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

(gg) Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

(hh) Bulb Length: Minimum 20 feet (6 m).

(ii) Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

(jj) Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-or automatic- reset switch that trips if temperature sensed
across any 12 inches (300 mm) of bulb length is equal to or above set point.

(kk) Bulb Length: Minimum 20 feet (6 m).

(ll) Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

(mm) Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

15 Humidistats

(a) Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

16 Actuators

(a) Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

(b) Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

(c) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

(d) Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

(e) Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

(f) Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

(g) Valves: Size for torque required for valve close off at maximum pump differential pressure.

(h) Dampers: Size for running torque calculated as follows:

(i) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.

(j) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.

(k) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

(l) Coupling: V-bolt and V-shaped, toothed cradle.

(m) Overload Protection: Electronic overload or digital rotation-sensing circuitry.
(n) Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.

(o) Power Requirements Spring Return: 24-V ac.

(p) Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

(q) Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).

(r) Run Time: 12 seconds open, 5 seconds closed.

17 Control Valves

(a) Control Valves: Factory fabricated, of type, body material, and pressure class BMSed on maximum pressure and temperature rating of piping system, unless otherwise indicated.

(b) Hydronic system globe valves shall have the following characteristics:

(i) NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

(ii) NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

(iii) Internal Construction: Replaceable plugs and stainless-steel or brass seats.

(iv) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

(v) Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate or the following:

(vi) Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.

(vii) Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

(viii) Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

(ix) Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

(c) Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.

(d) Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

(e) Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
Thermostatic Operator: Liquid-filled integral sensor with adjustable dial.

18 Dampers

(a) Dampers: AMCA-rated, opposed-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

(b) Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

(c) Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

(d) Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

15.3.7 Execution

1 INSTALLATION

(a) Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.
(b) Install averaging elements in ducts and plenums in crossing or zigzag pattern.

(c) Install guards on thermostats in the following locations:
   (i) Entrances.
   (ii) Public areas.
   (iii) Where indicated.

(d) Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

(e) Install labels and nameplates to identify control components

(f) Install hydronic instrument wells, valves, and other accessories

(g) Install refrigerant instrument wells, valves, and other accessories

(h) Install duct volume-control dampers

(i) Install electronic and fiber-optic cables

2 Electrical Wiring and Connection Installation

(a) Install raceways, boxes, and cabinets

(b) Install building wire and cable

(c) Install signal and communication cable

(d) Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

(e) Install exposed cable in raceway.

(f) Install concealed cable in raceway.

(g) Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

(h) Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

(i) Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

(j) Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

(k) Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

(l) Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3 Field Quality Control
(a) Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

(b) Perform the following field tests and inspections and prepare test reports:

(c) Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

(d) Test and adjust controls and safeties.

(e) Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

(f) Test each point through its full operating range to verify that safety and operating control set points are as required.

(g) Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

(h) Test each system for compliance with sequence of operation.

(i) Test software and hardware interlocks.

(j) DDC Verification:

   (i) Verify that instruments are installed before calibration, testing, and loop or leak checks.

   (ii) Check instruments for proper location and accessibility.

   (iii) Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

   (iv) Check instrument tubing for proper fittings, slope, material, and support.

   (v) Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

   (vi) Check temperature instruments and material and length of sensing elements.

   (vii) Check control valves. Verify that they are in correct direction.

   (viii) Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.

   (ix) Check DDC system as follows:

       (i) Verify that DDC controller power supply is from emergency power supply, if applicable.

       (ii) Verify that wires at control panels are tagged with their service designation and approved tagging system.

       (iii) Verify that spare I/O capacity has been provided.
(iv) Verify that DDC controllers are protected from power supply surges.

(k) Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

4 Demonstration

(a) Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.
16. **PAINTING**

16.1 **GENERAL**

16.1.1 **Related Documents**

1 The following alterations include specification clauses that amend or replace their corresponding clauses of Section 22 “Air Conditioning Refrigeration and Ventilation” of the Qatar Construction Specifications (QCS), or include clauses that are added to the Section,

2 Section 22 of the QCS and these alterations must be taken into consideration in conjunction with the preliminaries/General Conditions of the Contract.

3 Drawings and General Provisions of the contract, including General Conditions, Conditions of Particular Application and QCS Section 1, apply to Work of this Part.

16.1.2 **Description of Work**

1 This section covers the painting work, preparation and finishing of exposed exterior and interior surfaces as required by the Contract.

16.1.3 **Reference Standards**

1 Painting work shall be performed in strict accordance with the specifications and the stipulations of the Qatar Standard Specifications latest edition as noted herein below.

16.1.4 **Work Performance**

1 Include the prime painting of the exterior surface assigned under this section of the work unless specifically stated otherwise. In addition the final painting of all pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and all other mechanical items and equipment exposed to view in the mechanical equipment rooms and spaces. Colours to be determined by the Engineer. Galvanized iron, copper, brass and aluminum materials require no prime coat unless otherwise specifically called for.

16.2 **PRODUCTS**

1 As required by architect engineer.

2 All air outlets to be painted as required by architect.

16.3 **EXECUTION**

16.3.1 **Preparation and Requirements**

1 All metal surface, whether painted in the shop, the factory or in the field shall be thoroughly cleaned of all dirt, dust, grease or any other foreign matter, before the
priming coat is applied.

2 Expected duct work in underground parking shall be painted colour as directed by the Engineer.

3 Paint the interior of each fresh air chamber with two (2) coats of odorless, non-scaling paint where applicable.

4 Paint the interior of all ducts or register boxes, behind the grilles and registers, with two (2) coats of paint, and colour as directed by the Engineer.

5 All motors, and all other finished equipment shall be provided with three (3) coats of machinery enamel paint applied in the factory, and other installation shall be carefully cleaned, oiled and rubbed down.

6 Iron work exposed to view within the building, and not otherwise specified to be painted, such as angle supports, supports for apparatus, black iron partitions or casings, tanks, etc., shall be painted one priming coat of zinc chromate. All concealed iron work shall include a factory coat of paint.

7 Iron exposed to the weather, such as supporting or stiffening angles, exhaust ducts, vents, pipes, etc., shall be painted one priming coat of zinc chromate.

16.3.2 Finishing

1 After the final coat of paint has been applied to the fans and other equipment, the contractor shall paint on each unit and in a location that can be readily seen, the number of the unit and its service as indicated in the schedule. The letters shall be 50 mm in height and in black or white, to suit conditions.
SECTION 23

FIRE FIGHTING AND FIRE FIGHTING SYSTEMS
2. DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

2.1 GENERAL

2.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2.1.2 Summary

1 Section Includes:

(a) Fire-Alarm Control Panel
(b) Manual fire-alarm boxes.
(c) System smoke detectors.
(d) Combined photoelectric smoke and heat detectors.
(e) Heat detectors.
(f) Notification appliances.
(g) Magnetic door holders.
(h) Remote annunciator.
(i) Addressable interface device.
(j) System printer.

2.1.3 Definitions

1 LED: Light-emitting diode.

2.1.4 System Description

1 Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

2 Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

2.1.5 Performance Requirements

1 Seismic Performance: Fire-Alarm Control Panel and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

(a) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic
forces specified and the unit will be fully operational after the seismic event."

2.1.6 **Action Submittals**

1. **Product Data:** For each type of product indicated.

2. **Shop Drawings:** For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

   (a) Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.

   (b) Include voltage drop calculations for notification appliance circuits.

   (c) Include battery-size calculations.

   (d) Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

   (e) Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

   (f) Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

   (g) Retain subparagraph below for projects where routing of cable or conduit is critical and only outlet locations are shown on Drawings. Delete reference to device addresses if shown on Drawings.

   (h) Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

3. **General Submittal Requirements:**

   (a) Submittals shall be approved by authorities having jurisdiction prior to submitting them to Engineer.

   (b) Shop Drawings shall be prepared by persons with the following qualifications:

      (i) Trained and certified by manufacturer in fire-alarm system design.

      (ii) Licensed or certified by authorities having jurisdiction.

4. **Delegated-Design Submittal:** For smoke and heat detectors indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
(a) Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.

(b) Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

### 2.1.7 Informational Submittals

1. **Qualification Data**: For qualified Installer.

2. **Seismic Qualification Certificates**: For Fire-Alarm Control Panel, accessories, and components, from manufacturer.
   
   (a) **Basis for Certification**: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   
   (b) **Dimensioned Outline Drawings of Equipment Unit**: Identify center of gravity and locate and describe mounting and anchorage provisions.

   (c) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

3. **Field quality-control reports**.

### 2.1.8 Closeout Submittals

1. **Operation and Maintenance Data**: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals

   (a) Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

   (b) Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

   (c) Record copy of site-specific software.

   (d) Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

   (i) Frequency of testing of installed components.

   (ii) Frequency of inspection of installed components.

   (iii) Requirements and recommendations related to results of maintenance.

   (iv) Manufacturer's user training manuals.

   (e) Manufacturer's required maintenance related to system warranty requirements.

   (f) Abbreviated operating instructions for mounting at Fire-Alarm Control Panel.
2 Software and Firmware Operational Documentation:

(a) Software operating and upgrade manuals.
(b) Program Software Backup: On magnetic media or compact disk, complete with data files.
(c) Device address list.
(d) Printout of software application and graphic screens.

2.1.9 Maintenance Material Submittals

1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

(a) Revise subparagraphs below to suit Project.
(b) Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
(c) Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
(d) Insert flame detectors in Part 2 if retaining first option in subparagraph below.
(e) Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
(f) Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
(g) Keys and Tools: One extra set for access to locked and tamper proofed components.
(h) Audible and Visual Notification Appliances: One of each type installed.
(i) Fuses: Two of each type installed in the system.

2.1.10 Quality Assurance

1 Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

2 Installer Qualifications: Installation shall be by personnel certified technician.

3 Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

4 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5 NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.
6. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

7. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.

8. NFPA Certification: Obtain certification according to NFPA 72 by

2.1.11 Project Conditions

1. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Employer or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

   (a) Notify Employer no fewer than two days in advance of proposed interruption of fire-alarm service.

   (b) Do not proceed with interruption of fire-alarm service without Employer's written permission.

2.1.12 Sequencing And Scheduling

1. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

2. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

2.1.13 Software Service Agreement

1. Comply with UL 864.

2. Technical Support: Beginning with Substantial Completion, provide software support for two years.

3. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

   (a) Provide 30 days' notice to Employer to allow scheduling and access to system and to allow Employer to upgrade computer equipment if necessary.
2.2 PRODUCTS

2.2.1 Manufacturers

1 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2 Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following or approved equivalent:

(a) Honeywell (USA).
(b) Notifier (USA).
(c) Simplex (USA).
(d) Gamewell-FCI (USA).
(e) Siemens (GERMANY).
(f) GE Security–EST General Electric

3 The fire alarm system of all the buildings of the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Mashaf and shall be monitored from the ancillary building.

2.2.2 Systems Operational Description

1 Fire-alarm signal initiation shall be by one or more of the following devices and systems:

(a) Manual stations.
(b) Heat detectors.
(c) Smoke detectors.
(d) Duct smoke detectors.
(e) Verified automatic alarm operation of smoke detectors.
(f) Fire-extinguishing system operation.

2 Fire-alarm signal shall initiate the following actions:

(a) Continuously operate alarm notification appliances.
(b) Identify alarm at Fire-Alarm Control Panel
(c) Transmit an alarm signal to the remote alarm receiving station.
(d) Unlock electric door locks in designated egress paths.
(e) Release fire and smoke doors held open by magnetic door holders.
(f) Activate alarm communication system.
(g) Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.

(h) Activate smoke-control system (smoke management) at firefighter smoke-control system panel.

(i) Activate stairwell and elevator-shaft pressurization systems.

(j) Close smoke dampers in air ducts of designated air-conditioning duct systems.

(k) Recall elevators to primary or alternate recall floors.

(l) Activate emergency lighting control.

(m) Activate emergency shutoffs for gas and fuel supplies.

(n) Record events in the system memory.

(o) Record events by the system printer.

3 Supervisory signal initiation shall be by one or more of the following devices and actions:

(a) Valve supervisory switch.

(b) Low-air-pressure switch of a dry-pipe sprinkler system.

(c) Elevator shunt-trip supervision.

4 System trouble signal initiation shall be by one or more of the following devices and actions:

(a) Open circuits, shorts, and grounds in designated circuits.

(b) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

(c) Loss of primary power at Fire-Alarm Control Panel.

(d) Ground or a single break in Fire-Alarm Control Panel internal circuits.

(e) Abnormal ac voltage at Fire-Alarm Control Panel.

(f) Break in standby battery circuitry.

(g) Failure of battery charging.

(h) Abnormal position of any switch at Fire-Alarm Control Panel or annunciator.

(i) Fire-pump power failure, including a dead-phase or phase-reversal condition.

(j) Low-air-pressure switch operation on a dry-pipe.

5 System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at Fire-Alarm Control Panel. Record the event on system printer.
2.2.3 Fire-Alarm Control Panel

1 General Requirements for Fire-Alarm Control Panel:

(a) Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

   (i) System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

   (ii) Include a real-time clock for time annotation of events on the event recorder and printer.

(b) Addressable initiation devices that communicate device identity and status.

   (i) Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at Fire-Alarm Control Panel.

   (ii) Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

(c) Addressable control circuits for operation of mechanical equipment.

2 Alphanumeric Display and System Controls: Arranged for interface between human operator at Fire-Alarm Control Panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

(a) Annunciator and Display: Liquid-crystal type3 line(s) of 80 characters, minimum.

(b) Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

3 Circuits:

(a) Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.

(b) Initiating Device Circuits: Style D.

(c) Notification Appliance Circuits: Style Z.

(d) Signaling Line Circuits Style 7.

(e) Install no more than 100 addressable devices on each signaling line circuit.

(f) Serial Interfaces: Two RS-232 ports for printers.

4 Stairwell Pressurization: Provide an output signal using an addressable relay to start the stairwell pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.
(a) Pressurization starts when any alarm is received at Fire-Alarm Control Panel.

(b) Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

5 Smoke-Alarm Verification:

(a) Initiate audible and visible indication of an "alarm-verification" signal at Fire-Alarm Control Panel.

(b) Activate an NRTL-listed and -approved "alarm-verification" sequence at Fire-Alarm Control Panel and detector.

(c) Record events by the system printer.

(d) Sound general alarm if the alarm is verified.

(e) Cancel Fire-Alarm Control Panel indication and system reset if the alarm is not verified.

6 Notification Appliance Circuit: Operation shall sound in a pattern to be identified by the Contractor.

7 Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

8 Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

9 Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

10 Alarm Signaling Service: Central emergency communication system with redundant tone generators provided as a special module that is part of Fire-Alarm Control Panel.

(a) Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.

(b) Generate tones of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of Fire-Alarm Control Panel.

(c) Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
11 Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

12 Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals shall be powered by 24-V dc source.
   (a) Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

13 Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
   (a) Batteries: Sealed lead calcium.

14 Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.2.4 Fire Alarm Repeater Panel:

1 The fire alarm repeater panel shall consist of a LED / LCD display to annunciate all display on the main fire alarm panel.

2 RP shall contain all necessary micro-processors, electronic components and circuitry required to form an addressable device for direct connection to the loop circuits or main MFACP and operate in conjunction with the system circuitry / operational requirements.

3 It shall give secondary indication and control of the main MFACP and duplicate essential system controls for emergency conditions.

4 The message on the RP shall be displayed on alphanumeric 2 lines and 40 characters (minimum) LCD.

5 It shall have integral power supply and battery charger with twenty-four (24) hours with 30 minutes of alarm operation at the end of this period.

6 The RP shall be equipped with RS232 / RS485 port for connection with main MFACP.
2.2.5 Mimic Panel

1 LED Indicators onto a coloured zonal diagram, the LED will blinked to indicate the precise location of the alarm activation for ease of identification by site personnel during emergency.

2 Features :-

(a) Up to 100 LED indication point
(b) Programmable to display zones or individual devices
(c) Programmable to indicate Fire and Status condition
(d) Incorporated as a complete Mimic Panel

2.2.6 Data Network

1 Personal computer (PC) for network reporting terminal (NRT) is to be part of the data network with all information from the FACP relayed to the PC.

2 Network Media: The network is to be capable of communicating via fiber optic medium.

(a) Fiber Optic Network Communication: The network shall support fiber optics with the following specifications:
   (i) Size: 8 to 9 micrometers / 125 micrometers
   (ii) Type: Single Mode Os1, Dual fiber, Plenum rated
   (iii) Connector type: ST or better.
   (iv) Cables are to be class A style 7, fire rated or protected for one hour.

3 The fire alarm network of the Health Care Centers at Al Wakra, Al Mashaf, Umm Senim, Al Khor and Al Shamal shall be linked by the designed FO cabling to the Ancillary building where it will be monitored.

2.2.7 Manual Fire-Alarm Boxes

1 General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

(a) Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.

(b) Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
(c) Station Reset: Key- or wrench-operated switch.

(d) Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

(e) Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

(f) Protective shield shall be provided in public spaces or where required by the Client/Engineer.

2.2.8 System Smoke Detectors

1 General Requirements for System Smoke Detectors:

(a) Comply with UL 268; operating at 24-V dc, nominal.

(b) Detectors shall be four-wire type.

(c) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.

(d) Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

(e) Mounting: Surface or semi-recessed ceiling mounted type, located as shown on Drawings, with head removable from fixed twist-lock base. Removal of detector head is to interrupt supervisory circuit and cause trouble signal at control panel. Normal flat surface coverage is to be over 100 m² at mounting height of 6 m.

(f) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

(g) Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

(h) Circuitry for two-way communication with the [FACP]: Each time the detector is polled, it is to communicate its type (ionization, optical etc.) and an analogue/digitally-encoded value corresponding to its sensitivity and status with microcomputer processing in the control unit.

(i) Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at FACP for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACP.

(j) Smoke detectors installed in harsh environment (i.e. elevator hoistways) shall be manufactured and listed for use in harsh environment.

(k) Smoke detectors installed in plenum areas or above false ceiling shall be manufactured and listed for use in such places.
(a) Detector address shall be accessible from FACP and shall be able to identify the detector's location within the system and its sensitivity setting.

(b) An operator at Fire-Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
   (i) Primary status.
   (ii) Device type.
   (iii) Present average value.
   (iv) Present sensitivity selected.
   (v) Sensor range (normal, dirty, etc.).

3 Photoelectric Smoke Detectors: Include the following features:
   (a) Sensor: LED or infrared light source with matching silicon-cell receiver.
   (b) Detector Sensitivity: Between 0.008 and 0.011 percent/mm smoke obscuration.
   (c) combination smoke/thermal detectors are to be used. Combination smoke/thermal are becoming very popular and required by some Hotel Operators (such as Intercontinental)
   (d) Integral Thermal Detector: Fixed-temperature type with 57 deg C setting.

4 Beam-Type Smoke Detector
   (a) Beam-Type Smoke Detector: Each detector consists of a separate transmitter and receiver with the following features:
      (i) Adjustable Sensitivity: More than a six-level range, minimum
      (ii) Linear Range of Coverage: 180 m minimum.
      (iii) Tamper Switch: Initiates trouble signal at the FACP when either transmitter or receiver is disturbed.
      (iv) Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status. Any detector trouble, including power loss, is reported to the central FACP as a composite "trouble" signal.

5 Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   (a) Detector address shall be accessible from FACP and shall be able to identify the detector's location within the system and its sensitivity setting.
   (b) An operator at Fire-Alarm Control Panel, having the designated access level, shall be able to manually access the following for each detector:
      (i) Primary status.
      (ii) Device type.
      (iii) Present average value.
(iv) Present sensitivity selected.
(v) Sensor range (normal, dirty, etc.).
(c) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
(d) Each sensor shall have multiple levels of detection sensitivity.
(e) Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
(f) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.2.9 Combined Photoelectric Smoke And Heat Detectors: Include the following features:

1 Sensor: LED or infrared light source with matching silicon-cell receiver.
2 Detector Sensitivity: Between 0.008 and 0.011 percent/mm smoke obscuration.
3 Integral Thermal Detector: Fixed-temperature type with 57 deg. C (135 deg. F) setting.

2.2.10 Heat Detectors

1 General Requirements for Heat Detectors: Comply with UL 521.
   (a) Rate-of-rise temperature characteristic shall be selectable at FACP for 8 or 11 deg C per minute.
   (b) Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at FACP to operate at 57 or 68 deg C.
   (c) Number of settable levels in fire-alarm control unit varies among manufacturers and between detector types. Indicate specific number of levels on Drawings or in "Remarks" column of a detector schedule.
   (d) Provide multiple levels of detection sensitivity for each sensor.

2 Heat Detector, Combination Type: Actuated by either a fixed temperature of 57 deg C or a rate of rise that exceeds 8 deg C per minute unless otherwise indicated.
   (a) Mounting: Twist-lock base interchangeable with smoke-detector bases.
   (b) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.

2.2.11 Heat Detector Explosion Proof Type

1 Fixed heat detector explosion proof type shall be used in the battery rooms as indicating on drawings and shall be fixed-temperature sensing and settable at FACP to operate at 57 or 90 deg C.
2 The detectors shall be sensitive to visible and invisible products of combustion.

3 The detector shall be operated on explosion zones (1 & 2) using safety barrier.

4 The safety barrier module shall be located outside the explosion area.

5 The detector shall be connected to the FACP via zone monitor module located outside the explosion area.

2.2.12 Hydrogen Gas Detector

1 Hydrogen gas detectors shall be located at battery rooms as indicated on drawings and shall be compatible with NFPA 111 (Standard on Stored Electrical Energy Emergency and Standby Power Systems).

2 It shall use sensors to find out if there is dangerous level of hydrogen (H2) gas leak inside the battery room and it shall be connected to FACP to activate the audio visual alerts, also it shall have built-in light and sound to alert for gas leak.

3 Detector shall be adjusted for threshold level for example 15% of Lower Explosive Limit (LEL) to be able to set off an alarm, generally detector shall have at least number of three (3) alarm levels: 25% LEL, 50% LEL and 90% LEL.

4 Detector shall have 0.5% (LEL) resolution and shall have full scale range (0-100% LEL).

5 Detector shall be connected to the FACP via at least number of two (2) monitor modules.

2.2.13 Uv/Ir Flame Detector

1 The UV/IR flame detectors shall be capable of sensing radiant energy in the short wave section of both the ultraviolet and infrared portions of the electromagnetic spectrum. The signals from both sensors are analyzed for frequency, intensity and duration and trigger an alarm in case of fire.

2 The UV sensor shall incorporate a special logic circuit that helps prevent false alarms caused by solar radiation while the infra-red flame sensor shall employ narrow band optical filters that block unwanted radiation such as that emanating from the sun or tungsten filament lamps.

3 The UV/IR flame detectors shall be approved and listed by the Loss Prevention Council Board (LPCB) and manufactured under the appropriate category by the Underwriters Laboratories, Inc. (UL), and shall bear the “UL” label.

4 The UV/IR flame detector shall have a spectral range of 0.185 to 0.260 μm (micrometer) for UV radiation and 4.4 to 4.6 μm (micrometer) for IR radiation.

5 The UV/IR flame detector shall have 120 degree horizontal /95 degree vertical field of view and shall have response time less than 6 seconds.
6 The UV/IR flame detector shall be able to detect a fuel fire of 0.1 m² area from a distance ranging from 4 to 15 meter according to type of fuel:

(a) N-heptane (15m)
(b) Ethanol 95% (7.5m)
(c) LPG (5m)
(d) Gasoline (15m)
(e) Methanol (7.5m)
(f) Polypropylene Pellets (4m)
(g) Diesel Fuel (11m)
(h) IPA (Isopropyl Alcohol) (7.5m)
(i) Office Paper (5m)
(j) JP5 (11m)
(k) Hydrogen (5m)
(l) Kerosene (11m)
(m) Methane (5m)

7 The UV/IR flame detectors shall be designed to have high resistance to contamination and corrosion.

8 The UV/IR flame detector shall include intrinsically safe barrier located outside the explosion area which is suitable for use with safe area circuits.

9 The UV/IR flame detector shall incorporate an LED, clearly visible from the outside, to provide indication of alarm actuation.

10 The UV/IR flame detector shall be connected to the FACP via number of two (2) monitor modules.

2.2.14 Notification Appliances

1 General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.

2 General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

(a) Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

3 Areas with an average ambient sound level greater than 105 dBA shall require the use of a visible notification appliances in accordance with NFPA 72.
4 The total sound pressure level produced by combining the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance.

5 Notification appliances shall be listed for the purpose for which they are used.

6 Appliances intended for use in special environments, such as outdoors versus indoors, high or low temperatures, high humidity, dusty conditions, and hazardous locations, or where subject to tampering, shall be listed for the intended application.

7 Audible appliances shall provide a sound level of at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least 60 seconds or a sound level of at least 75 dBA, whichever is greater, measured at 1.5 m above the floor in all the areas.

8 Chimes, High-Level Output: Vibrating type, 94-dBA minimum rated output at three meter.

9 Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

(a) Rated Light Output:
   (i) 30 cd.
   (ii) 110 cd

(b) Mounting: Wall mounted unless otherwise indicated.

(c) For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

(d) Flashing shall be in a temporal pattern, synchronized with other units.

(e) Strobe Leads: Factory connected to screw terminals.

(f) Mounting Faceplate: Factory finished, red.

2.2.15 Magnetic Door Holders

1 Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

(a) Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.

(b) Wall-Mounted Units: Flush mounted unless otherwise indicated.

(c) Rating: 24-V ac or dc.

(d) Rating: 120-V ac.
2 Material and Finish: Match door hardware.

2.2.16 Addressable Interface Device

1 Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2 Integral Relay: Capable of providing a direct signal to circuit-breaker shunt trip for power shutdown >.

2.2.17 System Printer

1 Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

2.2.18 Device Guards

1 Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

(a) Factory fabricated and furnished by manufacturer of device.

(b) Finish: Paint of color to match the protected device.

2.2.19 Remote Annunciator And Repeater Panel

1 This is to be graphical annunciator panel located at each floor landing as specified on drawings and semi-flush wall mounted. Graphical displays are to be silk screened lines with colour-coded fire loops on white polycarbonate panel. LEDs are to be mounted to indicate fire alarms, wired to wiring terminal strip. Led would present the geographical location of fire.

2 Description: Duplicate annunciator functions of the Fire-Alarm Control Panel for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the Fire-Alarm Control Panel, including acknowledging, silencing, reset, and test.

3 Display Type and Functional Performance: Alphanumeric display same as the Fire-Alarm Control Panel. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the Fire-Alarm Control Panel.

4 Graphic Display Panel for Remote Annunciator: Wall-mounted engraved panel indicating the building floor plan with a "You Are Here" designation. Engrave zone, area, and floor designations on the face of the panel.

(a) Floor Plan Lines: Engraved in the surface and filled with colored paint. Floor plan lines are black and 6 mm wide.

(b) Engraved Legends: 6-mm- high minimum, in letters filled with red paint.
Mounting: Adjacent to remote annunciator.

### 2.3 EXECUTION

#### 2.3.1 Equipment Installation

1. Comply with NFPA 72 for installation of fire-alarm equipment.

2. Equipment Mounting: Install Fire-Alarm Control Panel on wall with tops of cabinet not more than 72 inches (1830 mm) above the finished floor.

3. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
   
   (a) Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

4. Smoke- or Heat-Detector Spacing:
   
   (a) Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
   
   (b) Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
   
   (c) Smooth ceiling spacing shall not exceed 30 feet (9 m).
   
   (d) Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A [or Appendix B] in NFPA 72.
   
   (e) HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
   
   (f) Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

5. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

6. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

7. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

8. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

9. Visible Alarm-Indicating Devices: Install at least 6 inches (150 mm) below the ceiling.
10 Device Location-Indicating Lights: Locate in public space near the device they monitor.

11 Fire-Alarm Control Panel: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

12 Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

2.3.2 Connections

1 Coordinate installation and specialty arrangements with Drawings and with requirements specified in related Sections. If Drawings are explicit enough, these requirements may be reduced or omitted.

2 For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

   (a) Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

3 Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

   (a) Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.

   (b) Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.

   (c) Smoke dampers in air ducts of designated air-conditioning duct systems.

   (d) Alarm-initiating connection to elevator recall system and components.

   (e) Alarm-initiating connection to activate emergency lighting control.

   (f) Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.

   (g) Supervisory connections at valve supervisory switches.

   (h) Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

   (i) Supervisory connections at elevator shunt trip breaker.

   (j) Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.

   (k) Supervisory connections at fire-pump engine control panel.
2.3.3 Identification

1 Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

2 Install framed instructions in a location visible from Fire-Alarm Control Panel.

2.3.4 Grounding

1 Ground Fire-Alarm Control Panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to Fire-Alarm Control Panel.

2.3.5 Field Quality Control

1 Field tests shall be witnessed by Engineer and authorities having jurisdiction.

2 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3 Perform tests and inspections.

   (a) Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

4 Tests and Inspections:

   (a) Visual Inspection: Conduct visual inspection prior to testing.

      (i) Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

      (ii) Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

      (iii) System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

      (iv) Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

      (v) Test audible appliances for the private operating mode according to manufacturer's written instructions.
(vi) Test visible appliances for the public operating mode according to manufacturer's written instructions.

(vii) Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

5 See Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

6 Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

7 Fire-alarm system will be considered defective if it does not pass tests and inspections.

8 Prepare test and inspection reports.

9 Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

10 Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

2.3.6 Demonstration

1 Train Employer's maintenance personnel to adjust, operate, and maintain fire-alarm system.
6. FIRE PROTECTION

6.1 GENERAL

6.1.1 Related Documents

1 Drawings and General provisions of Contract, including General and Supplementary Conditions apply to this section.

6.1.2 Description of Work

1 This section specifies Automatic fire sprinkler system, standpipe system, First-aid Fire Hose Reel system, Fire cabinets, Fire extinguishers & Automatic Clean Agent System. Materials and equipment specified in this Section include:
   (a) Pipe, fittings, valves, and specialties.
   (b) Fire Sprinklers.
   (c) Fire hose reel, Hose valves, fire cabinets and accessories.
   (d) Fire extinguishers.
   (e) Automatic Clean Agent.

2 Products furnished but not installed: Include sprinkler head cabinet with spare sprinkler heads.

6.1.3 System Description

1 Fire protection system is (for all types except type A – Al Wakkra Site; that use First-aid systems with Automatic Clean Agent for specific spaces) an automatic sprinkler system using automatic sprinklers and hose reels attached to a wet piping system and connected to the site fire water main network so that water discharges immediately from sprinklers, opened by fire, or from hose reel. The system is provided also with internal dry stand-pipe and hose valves. Various types of portable fire extinguishers and hose reels are distributed to provide first aid protection.

6.1.4 Related Sections

1 The following Sections contain requirements which relate to this Section:
   (a) Valves
   (b) Hangers and Supports
   (c) Steel Pipes and Fittings for Fire Protection Systems
   (d) Plumbing Works
6.1.5 Definitions

1. Pipe Sizes: used in this Specification are Nominal Pipe Size (NPS) in mm.

2. Other Definitions for fire protection systems are listed in NFPA 10, 13, 14, 20, 24, 25 and 2001 Standards.

3. Working Plans as used in this section means those documents (including drawings and calculations) prepared by contractor pursuant to the requirements contained in NFPA 13, 14 for obtaining the approval of the Engineer.

6.1.6 Submittals

1. Submit the following in accordance with Conditions of the Contract and all Specifications Sections.

2. Product Data: For each type of sprinkler head, valves, piping specialty, fire protection specialty, fire department connection, hose reel, fire extinguishers, fire cabinets and Clean Agent.


5. Record Drawings: At project close-out, submit drawings of installed systems in accordance with requirements of Specifications.

6. Maintenance Data: For each type of sprinkler head, valves, piping specialty, fire protection specialty, fire department connection, hose valves, hose reel, fire extinguishers and fire cabinets, for inclusion in operation and maintenance manual.

7. Samples: Submit catalogs or representative samples of all materials to be used in the work.

8. Install Welder’s Qualification Certificates

6.1.7 Quality Assurance

1. Design Criteria:

(a) Provide complete fire protection systems as indicated on the drawings and as required by local authorities.

(b) Where there is conflict between local authority (Qatar Civil Defense Department) requirements and the drawings, specifications or other standard agency requirements, the requirements of local authorities shall govern.
2 Installer Qualifications: Installation of fire protection piping, equipment, specialties and accessories, repair and servicing of equipment shall be performed only by a qualified installer, having a minimum of 5 previous projects similar in size and scope to this project and familiar with all precautions required. Submit evidence of such qualifications to the Engineer.

3 Qualifications for Welding Processes and Operators: Comply with the requirements of AWS D10.9, Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3".

4 Single Source Responsibility: Obtain components, and accessories from a single source. Include the source with responsibility and accountability to answer and resolve problems regarding compatibility, installation, performance and acceptance set.

6.1.8 Regulatory Requirements

1 Comply with the requirements of the following codes:
   - NFPA 10 Portable Fire Extinguishers
   - NFPA 14 Stand-pipe and hose systems
   - NFPA 13 Standard for the installation of sprinkler system
   - NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
   - NFPA2001 Standard on Clean Agent Fire Extinguishing Systems

6.1.9 Sequencing And Scheduling

1 Schedule rough-in installations with installations of other building components.

6.1.10 Extra Materials

1 Valve Wrenches: Furnish to Employer, 2 valve wrenches for each type of valves installed.

6.2 PRODUCTS

6.2.1 Manufacturers

1 Manufacturers are subject to compliance with the specification requirements of this section.

6.2.2 Pipes And Fittings

1 Above Ground Piping

   (a) 50 mm dia. and smaller, seamless, schedule 40 galvanized steel with
screwed malleable iron fittings and couplings.

(b) 65 mm dia. and larger, seamless, schedule 40 galvanized steel pipe with flanged couplings. The use of grooved couplings and fittings is also accepted.

2 Underground Piping Network

(a) 80 mm dia. and larger, HDPE pipe with Fusion welded joints and fittings & FM Approved.

6.2.3 Joining Materials

1 Welding Materials: Comply, with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

2 Gasket Materials: Thickness, material and type suitable for design temperatures and pressures.

3 Sealing Ring Materials: Shall be rubber sealing rings conforming to ISO 2531 Standard.

6.2.4 General Duty Valves

1 Valves used within the fire protection systems shall be UL listed, FM approved rated for 1200 KPa working pressure.

2 Gate Valves - 50 mm and Smaller: Body and bonnet of cast bronze, 1200 kPa cold water working pressure-non-shock, threaded ends, solid wedge, outside screw and yoke, rising stem, screw-in bonnet, and malleable iron handwheel. Valves shall be capable of being repacked under pressure, with valve wide open. UL listed, with normally open supervisory/tamper switch with double wire leads.

3 Gate Valves - 65 mm and Larger: Iron body; bronze mounted, 1200 kPa cold water working pressure-non-shock. Valves shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet, with body and bonnet conforming to ASTM A 126 Class B; replaceable bronze wedge facing rings; flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet, and bronze bonnet bushing. Valves shall be capable of being repacked under pressure, with valve wide open. UL listed, with normally open supervisory/tamper switch with double wire leads and rising stem.

4 Swing Check Valves: 1200 kPa cold water working pressure, cast iron body and bolted cap conforming to ASTM A 126, Class B; non slamming horizontal swing, with a malleable iron disc and flanged ends. Valve shall be capable of being refitted while the valve remains in the line. UL listed.

5 Butterfly Valve - 50mm and smaller: Bronze body butterfly valve, 1,200 kPa (12 bar), geared operator, visible position indicator, normally open supervisory/tamper switch with double wire leads, stainless steel disc and stem.
6  Butterfly Valve - 65mm and larger: Cast or ductile iron body butterfly valve, lug style, 1,200 kPa (12 bar), geared operator, visible position indicator, normally open supervisory/tamper switch with double wire leads, EPDM resilient seat, EPDM seals, nickel plated ductile iron disc. Valve assembly to be bubble tight to 12bar with no downstream flange/pipe attached. Use cap screws for removal of downstream piping while using the valve for system shutoff.

7  Globe Valves: Cast bronze body and screwed bonnet. Rubber, bronze or teflon disc, silicon bronze alloy stem, teflon-impregnated packing with bronze nut. Threaded or soldered end connections, and with aluminum or malleable-iron hand wheel.

6.2.5  Specialty Valves

1  Interior Automatic Air Vent: Float type hot pressed brass MS58 consists of two halves screwed together and fitted with O-ring seal, with rubber valve seal, plastic float, vacuum breaker complete with automatic self-sealing spring loaded brass check valve stainless steel spring and catch ring rated for 1200 KPa working pressure.

2  Alarm Check Valve: UL Listed, FM approved, 1200 KPa working pressure, designed for vertical or horizontal installations and have cast iron body, flanged inlet and outlet, bronze grooved seat with “O” ring seals, single hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, precision retard chamber, 6” water motor alarm, drip cup assembly piped without valves separate from main drain line, and fill line attachment with strainer.

3  The alarm check valve assembly shall be installed with upstream gate valve (outside screw and yoke) with supervisory switch in addition to a downstream flow switch. The assembly shall be provided with upstream and downstream pressure gauges. The assembly shall be installed outside the building at the tie-in connection prior to each fire water supply riser and to be underground inside a valve box complete with steel hinged valve box cover. The tamper switch and flow switch shall be connected to the main fire alarm panel and building management system.

4  Pressure Reducing Valves (PRV) Size– 65 mm and Larger:  UL listed, pilot operated regulator, globe pattern, cast iron body and cover internally coated with fusion bonded epoxy coating, cast iron disc retainer and diaphragm washer, bronze trim (disc guide, seat and cover bearing), stainless steel stem and spring. The valve shall be provided with the required pilot control.

5  Zone Control Valve Assembly: The zone control valve assembly shall include OS & Y gate valve with tamper switch, downstream flow switch, test and drain valve and pressure gauge.
6.2.6 Sprinklers

1 All sprinkler heads used within the fire protection systems shall be UL listed, FM approved, quick response type rated for 1200 kPa working pressure, designed to comply with NFPA requirements.

2 Upright Sprinkler: Automatic sprinkler, frangible bulb type, 79 degree C on basement and 68 degree on typical floors. temperature rating, bronze frame and deflector, 15 mm orifice and 15 mm thread with not less than 5.6 K-factor.

3 Concealed Pendent Sprinkler: Automatic sprinklers, frangible bulb type, 15 mm orifice and 15 mm thread with not less than 5.6 K factor. Brass deflector, brass frame, phosphor bronze button with gasket spring cover plate consists of beryllium nickel disc spring sealed on both its inside and outside faces with bronze compression screw. Cover plate color shall be matched with reflected ceiling color and to be coordinated and approved by the architecture. The temperature rating shall be 68 degree C for the sprinkler head while the cover plate temperature shall be 57 degree C.

4 Sidewall Sprinkler: Automatic sprinkler, frangible bulb type, 15 mm orifice and 15 mm thread. Sprinkler head shall be chrome plated with 79 degree C. temperature rating.

5 Window Sprinkler: Automatic sprinkler, frangible bulb type, 15 mm orifice and 15 mm thread. Sprinkler head shall be chrome plated with 68 degree C. temperature rating.

6 Sprinkler Head Cabinet and Wrench: Finished steel cabinet suitable for wall mounting, with hinged cover and space for spare sprinkler heads plus sprinkler head wrench. Provide separate cabinets for each style sprinkler head on the project.

6.1.3 Fire Hose Reels (FHR)

1 Fire hose reel shall be slim type, to be mounted inside fire cabinets either recessed or exposed, swinging type to comply or exceed with BS 5274/EN 671.

2 All the internal parts used shall be made of material according to BS 1490 LM 16/24. The hose tubing should be 25mm internal diameter rubber reinforced with double braiding and 30mtr long to comply with BS 3169 type 1 class B or EN 694.

3 The hose reel nozzle to comply with EN 671 -PN 16/DN 25/6.

4 The unit shall be complete with lock shield valve and 25mm pressure reducing valve to maintain pressure of 4.6 bar at outlet.

5 For testing and maintenance drain line with non return valve to be used. Brief operating instructions should be clearly displayed on each hose reel in both
languages, Arabic and English.

6.1.4 Fire Department Inlet Connection (SC)

1 Flush fire department connection, UL listed, cast brass body with drop clappers, size shall be 100 mm outlet and two 65 mm female inlets each provided with BS 336 instantaneous adaptor supplied by the fire department connection manufacturer.

2 The connection shall be provided with the necessary 65 mm nipples, snoots, plugs, chains and polished chrome plated wall plate lettered auto sprinkler.

3 Inlet Box

(a) The fire department inlet connection shall be housed in an inlet box with a glass fronted door and to be coordinated for location with the exterior of each building. The location shall be accessible to the fire trucks. The door should be as follows:

(b) Glazed with wired glass and conspicuously indicated by the words: "FIRE BRIGADE - WET MAIN INLET" or "WET RISER INLET" in block letters on the inner face of the glass, both in English and Arabic.

(i) Fastened only by means of a spring lock which can also be operated from inside without the aid of a key after the glass has been broken.

(ii) Made large enough for hose to be connected to inlets even if the door cannot be opened and the only means of access is by breaking the glass.

(c) The box should be constructed in accordance with BS 3980 with minimum dimensions 610mm x 400mm x 305mm.

(d) The box shall be built into the structure with a fall of one in 12 from the rear of the base to the front of the base. Construction material for the cabinet shall be brushed / polished stainless steel or as required by Architect/Engineer.

6.1.5 Fire Hose and Discharge Nozzle

1 Fire hose couplings shall be 65 mm diameter, cast brass finish, double pin lug, with two expansion rings, two tail and one swivel gasket. The couplings shall be polished chrome plated.

2 Nozzle should be made to aluminum alloy to BS 1490 and fitted with instantaneous adaptor as per BS 336 and should have settings as diffuser / jet / spray / on / off.

6.1.6 Fire Hose Couplings

1 Fire hose couplings shall be 65 mm diameter, cast brass finish, double pin lug, with two expansion rings, two tail and one swivel gasket. The couplings shall be
polished chrome plated.

6.1.7 Alarm and Water Flow Detection Devices

1 General: Types and sizes shall mate and match piping and equipment connected with. All equipment shall be UL listed and FM approved. All alarm and fire detection devices shall be monitored at the fire alarm panel. The fire alarm system shall be coordinated with the building management system BMS.

2 Water Flow Indicators: Electrical-supervision, vane type water flow detector, rated to 1700 kPa; designed for horizontal or vertical installation; have 2-SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere 125 volts AC and 0.25 ampere 24 Volts DC; complete with factory-set, field-adjustable retard element to prevent false signals, and tamper-proof cover which sends a signal when cover is removed.

3 Supervisory Switches: Electrical-supervision type, 2 SPDT, normally closed contacts, with switching component enclosed in submersible, weatherproof, and oil resistant NEMA Type 4 and P 6 enclosure, designed to signal valve in other than full open position.

6.1.8 Test and Drain Valve

1 The test and drain valves shall be smooth bore non-corrosive orifice gives flow equivalent to one nominal 15 mm orifice sprinkler. Each valve shall be complete with sight glass and can be operated with two directions TEST and DRAIN.

6.1.9 Fire Cabinet

1 Architrave shall be 20 SWG stainless steel (brushed / polished).

2 Door shall be 18 SWG brushed or polished stainless steel as per the Engineer requirement. Door shall be fixed to the cabinet by concealed hinges left or right as required to facilitate the hose reel pull direction.

3 Identification of the fire cabinet equipment shall be as per the Engineer requirement in compliance to NFPA 13, 14 Standards and shall be lettered on the cabinet in both Arabic and English languages.

4 Fire equipments shall be provided as specified elsewhere.

5 General: Provide fire cabinets for locations indicated, of suitable size for housing fire extinguishers, hose reels, valves, fire department connections and accessories of types and capacities indicated, in colors and finishes approved by the Engineer from manufacturer's standard, which comply with Drawings.

6 Construction: Manufacturer's standard enameled steel box, with trim, frame, door and hardware to suit cabinet type, trim style and door style indicated. Weld all joints and grind smooth. Miter and weld perimeter door frames. Stainless steel or steel door (as required by Arch./Engineer), frame and trim shall be used
7 Cabinet Type: With fire-resistance rating of wall where it is installed and suitable for mounting conditions indicated and of the following types:

(a) Type FHR1: Cabinet box fully recessed in walls of sufficient depth to suit style of trim indicated with Stainless steel door, sized to contain fire hose reel and one fire extinguisher.

(b) Type FHR2: Cabinet box fully exposed and mounted directly on wall, painted red, sized to contain fire hose reel and one fire extinguisher.

(c) Type FHR3: Cabinet box fully exposed and mounted floor supports, painted red, sized to contain fire hose reel and one fire extinguisher.

(d) Type FHC: Cabinet box fully exposed and mounted directly on wall, painted red, sized to contain fire hose valve and one fire extinguisher.

(e) Type FC1: Cabinet box fully exposed and mounted directly on wall, painted red, sized to contain two fire extinguishers (12 Kg dry powder type each).

(f) Type FC2: Cabinet box fully exposed and mounted directly on wall, painted red, sized to contain two fire extinguishers (6 Kg dry powder type each).

(g) Trim Style: Fabricate trim in one piece with corners mitred, welded and ground smooth.

(h) Exposed Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

(i) Trim Metal: Same metal as door.

8 Door Material and Construction: Manufacturer's standard door construction, of material indicated hereinafter, coordinated with cabinet types and trim styles selected.

FHR1 : Solid stainless steel door
FHR2, FHR3, FHC, FC1 : Solid steel door

9 Door Hardware: Provide manufacturer's standard door-operating hardware of proper type for cabinet type, trim style and door material and style indicated. Provide either stainless steel or brass material as indicated on Drawings, lever handle with cam action latch or door pull, concealed, and friction latch. Provide continuous-type hinge permitting door to open 180°.

10 Color: Provide color as selected by the Engineer from manufacturer's standard colors.

6.1.10 Fire Extinguishers

1 Fire extinguishers shall be 6 Kg dry powder type (FE1), 6 kg carbon dioxide type (FE2), 6 or 12 Kg (as per room volume) automatic dry powder with sprinkler head type (AFE1), 6 or 12 Kg (as per room volume) automatic FM200 with sprinkler
head type (AFE), 6 kg class k-fire dry powder fire extinguisher (FE3) and 50 Liter Foam fire trolley extinguisher (FE5) to the approval of the local authorities.

2 Fire extinguishers shall be provided as shown on the drawings and shall be furnished with wall bracket and/or shall be mounted inside Steel or stainless steel cabinets of suitable size. Identification of the fire extinguisher cabinet shall be as per the Architect requirement in compliance to NFPA 10 Standards.

3 The pressure test on the extinguishers shall remain valid for 5 years.

6.1.11 Fire Blanket (FB)

1 180 x 180 cm fire blanket with plastic container and mounting bracket. It is rated to BS476 Part4 and Class1 surface spread of flame to BS476 Part7.

6.1.12 Kitchen hood

1 Kitchen hood shall be protected with a wet-agent system consisting of agent storage tank(s), piping, nozzles, directed on appliances, inside hood and inside exhaust ducts, detectors and a control panel. The system shall be designed for automatic operation. A manual override pull station shall also be provided. Status signals shall be wired to the central control panel. The system shall be supplied and integrated with different building systems by the kitchen supplier.

6.1.13 Identification Signs

1 Drain valves, test valves, control valves & alarm check valves shall be fitted with approved enameled signs indicating their use.

6.2 EXECUTION

6.2.1 General

1 Cooperate with other trades to insure adequate space for equipment and piping placement.

2 Review plans, specifications and shop drawings of other trades to coordinate work.

3 Install in strict accordance with approved shop drawings.

4 Do not begin installation until local authority approval is submitted to the Engineer.

6.2.2 Examination

1 Examine rough-in for fire cabinets to verify actual locations of piping connections prior installing.

2 Examine walls for suitable conditions where cabinets are to be installed.
3 Do not proceed until unsatisfactory conditions have been corrected.

**6.2.3 Piping Installations**

1 Drawings (plans, schematics and diagrams) indicate the general location and arrangement of piping systems. So far as practical, install piping as indicated. Deviations from approved "Working Plans" for piping require written approval of the Engineer.

2 Install fire hose reel piping to provide for system drainage in accordance with NFPA 14.

3 Use approved fittings to make all changes in direction, branch takeoffs from mains and reductions in pipe sizes.

4 Install unions in pipes 50 mm and smaller adjacent to each valve. Unions are not required on flanged devices.

5 Install flanges or flange adapters on valves, apparatus and equipment having 65 mm and larger connections.

6 Provide hangers and supports in Compliance with the requirements of NFPA 13, NFPA 14 and part of Hangers & Supports.

7 Make connections between underground and above-ground piping using an approved transition piece strapped or fastened to prevent separation.

8 Install mechanical sleeve seal at pipe penetrations in walls and floors.

9 Provide pressure gauges with a connection not less than 6 mm and having a soft metal seated globe valve, arranged for draining pipe between gauge and valve.

10 Paint piping with two (2) coats of red lead and three (3) coats of red paint.

**6.2.4 Pipe Joint Construction**

1 Welded Joints: AWS D10.9, Level AR-3

2 Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

3 Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Align threads at point of assembly. Apply appropriate tape or thread compound to the external pipe threads. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded. Do not use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
4 Flanged Joints: Align flanged surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

5 Push-on Joints: AWWA C111-90.

6 Grooved-end Pipe and Grooved-end Fitting Joints: Use UL listed and FM approved grooved-end fittings and grooved-end couplings that are made by the same manufacturer and that are listed to be used together.

7 Groove pipe and assemble joints with grooved coupling, gasket, lubricant, and bolts according to coupling and fitting of manufacturers written instructions.

6.2.5 Valve Installations

1 Install fire protection specialty valves, fittings, and specialties in accordance with the manufacturer's written instructions, NFPA 13, 14 and the Engineer requirements.

2 Where there is more than one control valve, provide permanently marked identification signs indicating the portion of the system controlled by each valve.

6.2.6 Fire Cabinet Installations

1 Examine walls for thickness and framing for cabinets to verify cabinet depth and mounting prior to cabinet installation. Cabinets shall be built into walls unless otherwise indicated on Drawings.

2 Install items included in this section in locations and at mounting heights indicated, or if not indicated, at heights to comply with applications of governing authorities.

3 Prepare recesses in walls for fire cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.

4 Securely fasten mounting brackets and fire cabinets to structure, square and plumb, to comply with manufacturer's instructions.

6.2.7 Final Electrical Connections

1 Make connections of electric wiring to the electric equipment.

6.2.8 Fire Protection Block Plan

1 Provide a frame and glazed block plan showing the areas protected and positions of alarm valve. Locate the block plan as directed by the Engineer.

6.2.9 Remote Alarm

1 Ensure that the components of the systems include for the necessary provisions
to transfer visual and audible remote alarm signals. Carry out connections to the remote alarm contacts.

6.2.10 Field Quality Control

1. Flush, test, and hose reel piping systems in accordance with NFPA 13.

2. Replace piping system components which do not pass the test procedures specified, and re-test repaired portion of the system.

6.2.11 Flushing and Drainage

1. Provision shall be made for flushing the firewater sprinkler system.

2. All piping shall be provided where necessary or where shown on the drawings and at all sectional valves with a draining facility to help draining the major part(s) of the system.

3. On all risers 100mm diameter or larger, the drain valve shall be 50mm diameter size.

4. On 65mm diameter and 80mm diameter risers, the drain valve shall be 32mm diameter size.

5. On smaller risers, the drain valve shall be 20mm diameter size.

6. No direct interconnections shall be made between sewers and fire piping system drainpipes.

6.2.12 Spare Parts

1. As recommended by the manufacturer to cover a working period of two years, submit to the Employer, for approval, a priced list of the recommended spare parts and tools. The list should nominate the above-required items. The approved list shall be part from the operation and maintenance manuals.

6.2.13 Maintenance of The System

1. A maintenance schedule showing site visit and system testing shall be submitted to the employer for approval.

2. Maintenance shall be as per the conditions of the contract.

3. The system shall be maintained accordingly for a period of one year from the date of initial handing over and Employer’s acceptance.

6.2.14 Warranty

1. The system shall be warranted for parts and labor for not less than a period listed in the contract conditions from date of initial handing over of the work and Employer’s acceptance.
2 A system-checking schedule showing site visits shall be submitted to the employer for approval.
7.  FIRE WATER AND JOCKEY PUMPS

7.1  GENERAL

7.1.1 Related Documents

1  Drawings and general provisions of the Contract, including Contract Conditions apply to this Section.

7.1.2 Summary

1  This Section includes electric drive, horizontal fire water pump units, and pressure maintenance (Jockey) unit for fire-suppression systems comprises the following:

(a) Split-case fire water pump
(b) Pressure-maintenance (jockey) pump
(c) Fire water pump controllers
(d) Pressure-maintenance-pump controllers
(e) Fire water-pump specialties and accessories
(f) Pressure-maintenance-pump specialties and accessories
(g) Flow-measuring systems

7.1.3 Related Sections & Systems

1  Section For “Steel Pipes and Fittings” for above ground pipes and fittings.

2  Fire Alarm Systems for connections to alarm panel.

3  Power and connections to pump and fire pressure-maintenance-pump controllers.

7.1.4 Definitions

1  Fire Pump: Automatically operated horizontal-type pump used to supply fire water at rated capacity and total head required for fire-suppression service.

2  Fire Pump Unit: Assembly with fire pump, driver, controller, and related accessories.

3  Pressure-Maintenance Pump: Automatically operated electric-drive pump used to maintain potable water pressure in fire-suppression piping system.

4  Pressure Maintenance Pump Unit: Assembly with pressure maintenance pump, driver, controller and related accessories.

5  Split-Case Pump: Axially split-case, horizontal pump with its housing split parallel
7.1.5 System Performance Requirements

1 Fire-Pump Systems: Fire pump and pressure-maintenance pump units that comply with performance requirements specified and are compatible with fire-suppression systems.

7.1.6 Submittals

1 Product Data: Include rated capacities; certified pump performance curves with each selection point indicated; shipping, installed and operating weights; furnished specialties; and accessories for each fire-pump and pressure-maintenance-pump unit and flow-measuring system.

2 Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components and location and size of each field connection for each pump and pressure-maintenance-pump unit.

3 Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

4 Product Certificates: Signed by manufacturer of fire pumps and pump controllers certifying that products furnished comply with requirements.

5 Factory Test Report: Signed by one of the international recognized third party inspectorate.

6 The test shall be witnessed by the Employer.

7 Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

8 Maintenance Data: For each fire pump and pressure-maintenance-pump unit to include in maintenance manuals.

7.1.7 Quality Assurance

1 Manufacturer Qualifications: Firms whose fire pumps, pressure-maintenance pumps, drivers, controllers, and accessories are listed by product name and manufacturer in UL’s “Fire Protection Equipment Directory” and FM’s “Fire Protection Approval Guide” and that comply with requirements indicated.

2 The following are exceptions and are not required:

(a) UL listing and FM approval of pressure-maintenance pumps

(b) FM approval of pressure-maintenance-pump controllers
3 Source Limitations: Obtain fire pump and pressure-maintenance pump units through one source with responsibility and accountability to respond to and resolve problems regarding compatibility, installation, performance, and acceptance of units.

4 Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of fire pump and pressure-maintenance pump units and are based on specific models indicated. Other manufacturers pump units with equal performance characteristics may be considered. Refer to Section “Substitutions”.

5 Provide Listing/Approval Stamps, Label or other Marking on equipment made to specified standards.

6 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Employer.

7 Comply with standards of GPC pertaining to materials, hose coupling, hose threads, and installation.

8 Comply with NFPA 20, “Centrifugal Fire Pumps”, for fire pumps, drivers, controllers, accessories, and installation.

7.1.8 Delivery, Storage, and Handling

1 Preparation for Shipping: After assembling and testing fire pumps and pressure-maintenance pumps, protect flanges and exposed machined metal surfaces, pipe openings, and nozzles.

2 Retain shipping flange protective covers and protective coatings during storage.

3 Protect bearings and couplings against damage from sand, grit, or other foreign matter.

7.2 PRODUCTS

7.2.1 Fire Pumps

1 Provide complete fire pumps, starters and controls as shown on Drawings and specified, unless otherwise required by NFPA & QCD FSS6.7 Standards.

2 Main & Standby Fire Pumps: Provide fire pump set comprising one main fire pump electric driven and one standby fire pump electric driven in accordance with the NFPA 20 Fire Code. The main & standby fire pumps shall each be designed to deliver not less than 150 percent of rated capacity at not less than 65 percent of total rated head. The shut off head shall not exceed 140 percent of the rated head.

   (a) Horizontal Split Case Pump: Design Standard - NFPA

      (i) Construction
1) Casing: Close grained cast iron - heavy section. The casing shall be in two halves, suction and discharge branches being cast integral with the bottom half.

2) Case Wear Rings: Bronze - renewable.

3) Impeller: Bronze double suction enclosed type, machined externally and hand finished smooth internally. The impeller shall be keyed to the shaft for positive drive.

4) Shaft: Stainless steel.

5) Shaft Sleeves: Phosphor bronze or corrosion resistant steel-fitted to protect the shaft against wear, erosion and corrosion. The sleeves shall extend from the impeller right through the stuffing boxes and be renewable.

6) Stuffing Boxes: Of deep design for proper sealing. Split glands, in corrosion resistant

7) Bearings: Ball or roller - grease lubricated. Mounted in housings spigotted to ensure perfect alignment.

8) Coupling: Flexible type, with guard.

9) Base plate: Steel - extended to carry the driving unit.

(ii) Accessories Fitted

1) Automatic Air To automatically release air from Release Valve: the pump.

2) Pressure Gauge: Connected near the pump discharge branch.

3) Compound Connected near the pump suction Pressure Gauge: branch.

(b) Electric Motor

(i) Horizontal foot mounted squirrel cage - Nema MGI Standard

(ii) Design Standard - NFPA

(iii) Design Specification: The motor shall be suitable for use on an electric supply of 415 ± 6% volts, 3 phase, 50 Hz, having Class 'F' insulation with a maximum temperature rise of 115°C (at service factor load) in an ambient temperature of 50°C.

1) Enclosure: TEFC.

2) Degree of NEMA weather protected Type 1.

3) Protection:

4) Rating: NEMA standard MGI Design B.

5) Insulation Class 'F'.

6) Service Factor:1.15.
1) Stator Frame: Cast iron.
2) Stator Core: High quality low loss sheet steel stampings.
3) Stator Windings: Synthetic enamel covered wire fully insulated from the core and between phases. Double impregnation to provide high resistance to moisture and chemical contamination.
4) Rotor Core: High quality low loss sheet steel stampings.
5) Rotor Windings: Cage of die cast aluminium.
6) Shaft: High grade steel machined all over very close limits.
7) Bearings: Ball grease lubricated.
8) Conduit Box: Arranged for reception of six leads engraved with the terminal markings so that leads are clearly identified.

(c) Electric Control Panel
(i) Design Standard - NFPA
(ii) Design Specification: The controller shall start the fire pump automatically on detecting a pressure drop in the fire protection system and continue to run until shut down manually.
(iii) Construction: The starter unit shall be housed in a dust and damp protecting sheet steel enclosure with hinged lockable front access door and removable undrilled gland plates.
1) Enclosure: NEMA, Type 2.
2) Supply: 415 ± 6% volts, 3 phase, 50 Hz.
3) Mounted on the panel: One over-riding manual start trip lever to provide start independent of all other circuitry.
   One over-riding manual Star to Delta changeover switch.
   One single pole normally open 'stop' push-button.
   One isolating handle with provision for padlocking in the 'on' position.
   One spring charge handle for manually compressing the circuit breaker main spring.
   One moving iron ammeter to give indication of current.
4) Lamps to provide visual indication of:
a) Electric supply failed  
b) Auto-start ready  
c) Pump on demand  
d) Pump running  
e) Pump failed to start  
f) One lamp test push-button.

5) Mounted inside the panel:  
   a) One triple pole air circuit breaker to provide automatic and manual starting of the motor. The circuit breaker shall perform the duty of the main contractor and give locked rotor an instantaneous short circuit protection.  
b) Contractors for Star and Delta switching.  
c) Star to Delta changeover timer.  
d) Door interlocking triple pole isolator.  
e) Main neutral link.  
f) Relays for monitoring main power supply.  
g) Control relays.  
h) HRC fuses to protect indicator and relay circuits.  
i) Fused terminals for voltmeter testing.  
j) One set of main power terminals.  
k) One set of control and alarm terminals, "Motor running conditions", "loss line power", and line power phase reversal.  
l) Pressure switch actuated by fall in pressure in the fire protection system.

3. Jockey Fire Pump  
   (a) Provide an electric powered jockey fire pump of vertical multi-stage type with direct mounted motor.  
   (b) Pump and Motor  
      (i) Construction: The motor shall be totally enclosed fan squirrel cage type with Class 'F' insulation, designed and sized for maximum output at an ambient temperature of 50°C. The motor shall be suitable for an electrical supply of 415 ± 6% volts, Three phase, 50 cycles.  
         1) Suction and Cast iron.  
      (ii) Delivery:  
         1) Intermediate Cast iron.
(iii) Chambers:
1) Diffusers: Stainless steel.
2) Impellers: Stainless steel.
3) Shaft: Stainless steel.
4) Shaft Seal: Mechanical having diamond polished tungsten carbide seal faces.
5) Bearings: Rubber

(c) Electric Motor Starter
(i) Design specification: The pump operation shall be controlled by pressure switch. The jockey pump shall automatically start and stop at the pre-determined pressure settings.
(ii) Construction: The starter unit is housed in a dust and damp protecting sheet steel wall fixing enclosure, with thermoplastic front cover, having knockouts top and bottom for cable arrangement.
1) Enclosure - NEMA, Type 2, TEFC.
2) Mounted on the panel shall be:
   a) One isolating switch
   b) One 'Push to Run' button
   c) One reset push-button
3) Mounted inside the panel shall be:
   d) One front cover interlocking triple pole isolator.
   e) One direct on line starting triple pole contractor
   f) One thermal three phase overload unit.
   g) The jockey pump starter shall be manufactured by the same manufacturers as the main fire pump controllers.

4 Power Supply
(a) The electric supply must be obtained from the building main supply and the emergency power supply that comply with requirements of QCD FSS1.1.
(b) An automatic warning of power failure to the motor starting switch or of any one phase of the supply shall be given visually and audibly at the Fire Alarm Control Panel. Power for this warning system must not be taken from the supply circuit to the motor. Where the power is taken from a battery, the battery must be trickle charged and have a capacity sufficient to provide an alarm for 72 hours duration.
(c) The following warning label shall appear adjacent to the isolating switch:
   (i) Warning-do not open or close this switch while the circuit breaker (disconnecting means) is in closed position.
(ii) Label to be in Arabic and English.

(d) The electric connections shall be such that a power supply is always available for the motor when the switches for the distribution of the other power throughout the premises are open. Any switches on the power feed to the motor must be clearly labelled "FIRE MOTOR SUPPLY NOT TO BE SWITCHED OFF IN THE EVENT OF FIRE", including any switches located in the Generator Room. Labels shall be in Arabic and English.

(e) Provide adequate earthing for all motors and control panels. Connect the earthing wires to the building earthing network.

5 BMS CONNECTION

(a) The control panels shall be processor base and capable of integration to a BMS system. All software and hardware required for the integration must be included in the package. Coordinate with BMS system.

7.2.2 Spare Parts

1 Provide spare parts sufficient for two (2) years service for all fire protection equipment and devices.

7.2.3 Strainers

1 Cast iron dirt box type strainers to fire pump suction line, with perforated copper strainer and flanged ends.

7.2.4 Vortex Inhibitors

1 Polypropylene vortex inhibitor for pump suction pipes or approved equal.

7.3 EXECUTION

7.3.1 Examination

1 Examine areas, equipment foundations, and conditions, for compliance with requirements for installation and other conditions affecting pump performance.

2 Proceed with installation only after unsatisfactory conditions have been corrected.

3 Examine roughing-in of fire suppression piping systems. Verify actual locations of piping connections before pump installation.

7.3.2 Concrete Bases

1 Install concrete bases of dimensions required for fire pumps, pressure maintenance pumps, and controllers. Refer to "Cast-in-Place Concrete" works.
7.3.3 Installation

1. Comply with fire pumps, pressure maintenance pump, and controller manufacturers’ written installation and alignment instructions, and with NFPA 20.

2. Install pumps and controllers to provide access for periodic maintenance, including removal of drivers, impellers, couplings, and accessories.

3. Set base mounting type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

4. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near foundation bolts to provide 19-38 mm gap between pump base and foundation for grouting.

5. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and pump suction and discharge flanges to verify that they are level and plumb.

6. Install suction and discharge piping equal to or greater than diameter of fire pump nozzles but not less than NFPA requirements.

7. Install valves that are the same size as piping connecting fire pumps, bypasses, test headers, and other piping systems to NFPA 20.

8. Install pressure gages on pump suction and discharge at pressure gage tappings.

9. Support pumps and piping separately so weight of piping does not rest on pumps.

10. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.

11. Refer to basic piping installation and joint construction.

12. Install water supply and drain piping for diesel engine heat exchangers. Extend drain piping from heat exchangers to point of disposition.

13. Install exhaust system piping for diesel engine. Extend to the nearest floor drain. Install pipe and fittings with welded joints. and components having flanged connections with gasketed joints.

14. Install flow meters and sensors where indicated. Install flow measuring system components and make connections according to manufacturer’s written instructions.

15. Electrical Wiring: Install electrical devices furnished by equipment manufacturers.
but not specified to be factory mounted. Furnish copies of manufacturer’s wiring
diagram submittals to the Company.

16 Verify that electrical wiring is installed according to manufacturers’ submittal and
installation requirements in electrical Sections. Proceed with equipment startup
only after wiring installation is satisfactory.

7.3.4 Alignment

1 Align fire pump and driver shafts after complete unit has been levelled on
foundation, grout has set, and foundation bolts have been tightened.

2 After alignment is correct, tighten foundation bolts evenly but not too firmly. Fill
baseplate completely with grout, with metal blocks and shims or wedges in place.
Tighten foundation bolts after grout has hardened. Check alignment and make
required corrections.

3 Make piping connections, check alignment, and make required corrections.

4 Alignment Tolerances: Comply with manufacturer’s written instructions.

7.3.5 Connections

1 Piping installation requirements are specified in, Fire specs and Plumbing Specs.
Drawings indicate general arrangement of piping and specialties. The following
are specific connection requirements:

(a) Install piping adjacent to fire and pressure maintenance pumps to allow
service and maintenance.

(b) Connect water supply from water tanks to fire and pressure maintenance
pumps.

(c) Connect fire pumps and pressure maintenance pump discharge piping to
the fire suppression piping.

(d) Connect relief valve discharge to test line back to fire water tank.

(e) Connect cooling system water supply and drain piping to diesel engine heat
exchangers.

(f) Connect exhaust system piping to diesel engines.

2 Connect flow measuring system meters and sensors according to manufacturer’s
written instructions.

3 Connection of pump controllers to building fire alarm system and to building
management system (BMS). Refer to “Fire Alarm” works for Electrical Wiring and
Connections.

4 Ensure that factory connection of controllers to pumps are correct.

5 Ground equipment
6. Tighten electrical connectors and terminals according to manufacturer’s published torque tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

7.3.6 Field Quality Control

1. Manufacturer’s Field Services: Engage a factory authorized service representative to inspect field assembled components and equipment installation, including fire pump and pressure maintenance pump units, piping, and electrical connections. Report results in writing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Check suction line connections for tightness so no air gets into pump.

4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

6. Final Checks before Startup: Perform the following preventive maintenance operations and checks:

7. Lubricate oil-lubrication type bearings.

8. Remove grease-lubrication type bearing covers, flush bearing with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer’s written instructions.

9. Disconnect coupling and check diesel engine for proper rotation. Rotation shall match direction of rotation marked on pump casing.

10. Verify prior to pump connection to engine, that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.

11. Starting Procedure for Pumps is as follows:

(a) Install coolant in cooling system. Fill closed loop cooling system with potable water and add rust inhibitor.

(b) Start engine.

(c) Open discharge valve slowly.

(d) Observe leakage from stuffing boxes and ensure lubrication of packing. Do not tighten gland immediately but let packing run in before reducing leakage through stuffing boxes.
(e) Check general mechanical operation of pump and driver.

12 Perform Field Tests for each fire-pump unit and system piping when installation is complete. Comply with operation instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire-pump unit performs as indicated. Report test results in writing.

7.3.7 Demonstration

1 Engage a factory authorized services representative to train Owner’s maintenance personnel to adjust, operate, and maintain units as specified below:

(a) Train Owner’s maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining units.

7.3.8 Data Sheet

1 For Each Site the fire pump equipment data sheet details; kindly refer to equipment’s schedule on the following drawings:

(a) Al Wakkra Site: Dwg. No. P-11-601.
(b) Al Mashaf Site: Dwg. No. P-21-601.
(c) Umm-Snim Site: Dwg. No. P-31-601.
(d) Al Khor Site: Dwg. No. P-41-601.
(e) Al Shamal Site: Dwg. No. P-51-601.
8. CLEAN AGENT FIRE EXTINGUISHING SYSTEM

8.1 GENERAL

8.1.1 Related Documents

1 Drawings and general provisions of Contract, including General Conditions, Conditions of Particular Application apply to this section.

8.1.2 Description

1 This section covers the clean agent fire extinguishing systems.

8.1.3 Reference Standards

1 Comply with the applicable requirements set forth in the latest edition of the listed standards, and the Qatar Construction specification rules and regulations guide for fire protection works for the design, equipment, installation, testing and maintenance of clean agent extinguishing systems:

(a) National Fire Protection Association
(b) NFPA No.
(c) 2001 Clean Agent Fire Extinguishing Systems
(d) 70 National Electrical Code
(e) 72 National Fire Alarm Code
(f) 75 Electronic Computer System

8.1.4 Submittals

1 Submit the following in accordance with Conditions of Contract and all specification sections:

2 Field installation layout detailing the location of agent storage tanks, pipe runs including pipe sizes and lengths, control panel(s), detectors, manual pull stations, abort stations, audible and visual alarms, etc.

3 Auxiliary details and information such as maintenance panels, door holders, special sealing requirements and equipment shutdowns.

4 Separate layouts and isometric details for each protected area.

5 Electrical layout drawings showing the locations of devices and include point-to-point conduit runs.

6 Internal control panel wiring diagram including power supply requirements and field wiring termination points.
7 Graphic annunciator wiring schematics and dimensioned display panel illumination.

8 Design to be in compliance with NFPA 2001 with complete dynamic flow calculations, from approved computer program.

9 Calculations for battery standby power supply taking into consideration the power requirements of alarms, initiating devices and auxiliary components under full load conditions.

10 Record Drawings: At project close-out, submit drawings of installed systems in accordance with requirements of Specification Sections.

11 Operation and Maintenance Manual for the systems and equipment.

12 Sequence of operation detailing alarm devices, shutdown functions, remote signaling, damper operation, time delay and agent discharge for each system.

8.1.5 System Description and Operation

1 Total flooding clean agent extinguishing system.

2 The system provides 7.5%, by volume, minimum design concentration and includes required mechanical and electrical installation, detection and control equipment, agent storage cylinders, clean agent as HFC-227ea.

3 (FM-200) manufactured by great lakes, USA, or approved equal, nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shut down, alarm interface, caution/advisory signs and functional checkout and testing.

4 The system shall be actuated by an optical smoke detectors installed at a maximum spacing of 25 m² per detector. If air flow exceeds one air change per minute, optical detectors shall be installed at spacing not exceeding 12.5 m² per detector. Detectors shall be wired to provide double knock signal using verified detection method of operation.

5 The automatic operation of each protected area shall be as follows:

   (a) Actuation of one (1) detector, within the system, shall:

6 Illuminate the “ALARM” lamp on the control panel,

7 Energize an alarm bell and visual indicator located inside protected areas,

8 Transfer two (2) sets of 10 Amp rated auxiliary contacts which shall operate door holders/activate fire curtains, transmit a signal to fire alarm panel and to shutdown HVAC equipment / dampers.

   (a) Actuation of a second detector, within the system, shall:
9 Illuminate a “PRE-DISCHARGE” lamp on the control panel,
10 Energize an alarm horn/strobe device located outside protected areas,
11 Start time-delay sequence (not to exceed 30 second),
12 Enable system abort sequence,
13 Shut down the HVAC system and / or close dampers.

(a) After completion of the time-delay sequence, the agent shall be discharged and the following shall occur:
(b) Illuminate a “SYSTEM FIRED” lamp on control panel,
(c) Shut down of all power to equipment.
(d) The system shall be capable of being actuated by manual discharge device located at exit of the protected area. Operation of a manual device shall duplicate the “Verified Detection” sequence described above except the time delay and abort functions shall be by passed. The manual discharge station shall be of the electrical actuation type and shall be supervised at the main control panel.

8.1.6 Approvals

1 All basic equipment shall be formally approved by at least one international recognized testing laboratory such as: VDS, CNPP, LPC, UL or FM.

8.1.7 Related Sections & Works

1 The following works include requirements which relate to this section:

2 Basic Electrical Materials and Methods
3 Fire Alarm System

8.2 PRODUCTS

8.2.1 Piping

1 Comply with NFPA 2001, Section 2.2.
2 Piping material dimensions and material shall be as mentioned below.
3 Inert Gas Clean Agent System Piping
4 Piping Upstream of Pressure Reducer

(a) Pipe: Schedule 80, C-St to ASTM A106 Gr. B/A53 Gr. B. to be connected by welding
(b) Fittings: Socket weld type Class 6000 up to 1 ½", C-St. ASTM A105.
(c) 2" and larger, butt welding WT to match pipe schedule, C-St to ASTM A234 Gr. WPB.
(d) Flanges: Forged carbon steel, welding neck type Class 1500 RF; WT to match pipe schedule, C-St to ASTM A105.

5 Piping Downstream of Pressure Reducer
(a) Pipe: Schedule 80 for sizes up to 1 ½".
(b) Schedule 40 for sizes 2" and larger, C-St. to ASTM A106 Gr. B/A53 Gr. B.
(c) Fittings: Socket weld type Class 3000 up to 1 ½", C-St. ASTM A105.
(d) 2" and larger, butt welding WT to match pipe schedule, C-St to ASTM A234 Gr. WPB.
(e) Class 300 malleable iron screwed fittings up to 3".
(f) 1000 lb rated forged steel screwed fittings 4" and larger.
(g) Flanges: Welding neck type Class 600 RF; WT to match pipe schedule, C-St to ASTM A105.

6 Halocarbon Clean Agent System Piping
(a) Pipes: Seamless steel pipes schedule 40 to ASTM A 53 Grade B. Nonmetallic pipes are not allowed.
(b) Fittings: Malleable iron fittings rated 2000 kPa (300 lb class) to ASTM A 197. Fittings rated 1000 kPa are not allowed.
(c) Jointing: Threaded, welded, flanged and grooved as long as they conform to the above requirements. Do not use hole-cut fittings.
(d) All piping must be galvanized.
(e) Welding on pipes and fittings shall be cold dip coated following installation.
(f) Pipe hangers and supports shall be to MSS SP-58, MSS SP-69 and MSS SP-90 and shall be hot-dip galvanized and listed for fire protection service.

8.2.2 Centralized Battery of Cylinders
1 Assembly of cylinders. The main of the slave cylinders is made within the disk breaks receiving the pressure coming from the pilot cylinder. The slave cylinders have a pneumatic release cone, ¼" TE, ¼" Teflon hose, discharge hose and non-return valve.
2 The assembly is completed with discharge manifold with the suitable diameter to obtain the discharge of the extinguishing agent in the right time. It also has a union joint in one of the sides and pressure switch for manifold. Set of brackets, flange, protective cap for main valve and decompression screw.
8.2.3 Discharge Nozzles

1. Gray anodized aluminum nozzle either of 360° or 180° discharge patterns.

8.2.4 Detectors

1. Provide optical smoke detectors in protected areas.

2. Detectors shall be documented compatible with the control equipment to which it is connected. The detectors shall obtain their operating power from the control panel.

3. To minimize nuisance alarms, voltage and RF transient suppression techniques shall be employed as well as an insect screen. All detector designs shall provide full solid-state construction.

4. Each detector base or the detector itself shall have a flashing status indicating LED for visual supervision. When the detector is activated, the flashing LED will latch on steady and at full brilliance until it is reset by the reset switch, from the control panel.

5. Detectors shall be plug-in lockable with separate base.

6. The detectors shall be sensitive to visible and invisible products of combustion.

8.2.5 Control Panel

1. Listed "Releasing Device" to perform the functions necessary to operate the system detections, actuation and auxiliary system functions a per NFPA requirements and outlined here below.

2. Provide wall mounted, 18 ga. metal cabinet suitable for electrical circuits with a hinged, locked door painted with approved finish, 240 VAC, 50 HZ, audible and visual "Trouble" signals event a loss of A/C, rectified or battery power occurred, self-contained 24 VDC emergency power supply including a battery charger and rechargeable batteries with a minimum rating of 6 Amp hours.

3. Include in addition to the above the following features in a single enclosure:
   (a) 3 audible circuits - each rated 24 VDC, 0.25 A
   (b) 3 audible silence switches
   (c) 7 sets of 10 A auxiliary contacts
   (d) 10 diagnostic LED's for easy trouble shooting
   (e) Solid-state, field programmable time delay 0-60 seconds
   (f) 4 abort options
   (g) Protective covers over high voltage terminals
   (h) Connections to power a remote annunciator
(i) Incoming power circuit breaker. Not a fuse
(j) Agent cylinder isolating switch for facilitating the testing. Operation of the switch cause a trouble signal
(k) Verified detection
(l) Parallel wired agent release modules
(m) Class "A" wiring of detection and agent release circuits.

4 The supplied control panel shall be microprocessor base and capable of integration to a BMS system. All software and hardware required for the integration must be included in the package. Coordinate with BMS system.

8.2.6 Manual Release Switch

1 Dual action device for manual discharge of the agent. The manual actuation shall bypass the time delay and abort functions, shall cause the system discharge and shall cause all alarm and shutdown devices to operate in the same manner as if the system had operated automatically.

8.2.7 Abort Station

1 Locate next to each manual release switch and shall be supervised and shall indicate a trouble condition at the control panel if depressed.

8.2.8 Audible and Visual Alarms

1 Provide 150 mm dia alarm bell, alarm horn and visual alarm strobe with label attached to strobe lens.

8.2.9 Caution / Advisory Signs

1 Provide, in Arabic and English, signs as required to comply with NFPA commendations at entrance to each protected area, for manual discharge stations, for flashing light over each exit from a protected space.

8.2.10 Fire Doors to Protected Areas

1 Fit automatic self-closing doors at all entrances to protected areas. Provide each door/leaf with electrically actuated magnetic door holder to close the door automatically upon receiving a signal from the control panel. The doors shall also close manually.

8.2.11 Fire Curtains

1 Roll up type, fiber glass installed in such a manner that upon receiving a signal from the control panel, in case of fire, the holding mechanism will let loose the curtain to fall through a "U" channel guide.
8.2.12 Wall Penetration

1 Seal all openings in walls, floors or ceilings within the protected areas with 2 hours rated fire-proof sealant.

8.2.13 Overpressure Vent Device

1 Provide overpressure vent devices complete with flaps and frames when using inert gas systems.

8.2.14 Wiring and Conduits

1 As specified in Electrical & Fire alarm sections.

8.3 EXECUTION

8.3.1 Installation

1 All installation shall be in accordance with manufacturer's written instruction and NFPA Standards and shall be earthed.

8.3.2 System Inspection and Checkout

1 Check the entire system after the system installation has been completed by qualified, trained personnel in accordance with the manufacturer's recommended procedures and NFPA standards:

(a) Check for proper mounting and installation all containers and distribution piping.

(b) Test for proper connection, continuity and resistance to ground all electrical wiring.

(c) Functionally test the complete system in the presence of the Engineer or his representative and all functions, including system and equipment interlocks, must be operational at least five (5) days prior to the final acceptance tests.

2 Test each detector in accordance with the manufacturer's recommended procedures, and test values recorded.

3 All system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, local and remote alarms, etc., shall function as required and designed.

4 Test each control panel circuit for trouble by inducing a trouble condition into the system.

8.3.3 Training Requirements

1 Prior to final acceptance, provide operational training to each shift of the Employer personnel. Each training session shall include system control panel
operation, manual and abort functions, trouble procedures, auxiliary functions and emergency procedures.

8.3.4 Operation and Maintenance

1 Prior to final acceptance, provide complete operation and maintenance instruction manuals, six (6) copies for each system, to the Engineer. Detail all aspects of system operation and maintenance, including piping isometrics, wiring diagrams of all circuits, a written description of the system design and sequence of operation, drawing(s) illustrating control logic and equipment used in the system. Include in the manual checklists and procedures for emergency situations, troubleshooting techniques and maintenance operations and procedures.

8.3.5 Record Drawings

1 Upon completion of each system, provide six (6) copies of system "Record" drawings to the Engineer. The drawings shall show actual installation details including all equipment locations (i.e. control panel(s), agent container(s), detectors, alarms, manuals and aborts, etc.), as well as piping and conduit routing details. Show all room or facilities modifications, including door and/or damper installations completed. Provide one (1) copy of reproducible engineering drawings plus one (1) copy of electronic files reflecting all actual installation details.

8.3.6 Acceptance Tests

1 At the time "Record" drawings and maintenance/operations manuals are submitted, submit a "Test Plan" describing procedures to be used to test the clean agent system(s). The Test Plan shall include a step-by-step description of all tests to be performed and shall indicate the type and location of test apparatus to be employed. The tests shall demonstrate that the operational and installation requirements of this specification have been met. All tests shall be conducted in the presence of the Engineer and shall not be conducted until the Test Plan has been approved.

2 The tests shall demonstrate that the entire control system functions as designed and intended. All circuits shall be tested: automatic actuation, manual actuation, HVAC and power shutdowns, audible and visual alarm devices, manual override of abort functions and agent container pressure supervision. Supervision of all panel circuits, including AC power and battery power supplies, shall be tested and qualified.

3 Upon acceptance by the Owner, the completed system(s) shall be placed in normal service.

8.3.7 System Inspections

1 Provide two (2) inspections of each system, installed under this contract, during the one-year warranty period. The first inspection shall be at the six month
interval, and the second inspection at the twelve month interval, after system acceptance. Inspections shall be conducted in accordance with the manufacturer's guidelines and shall comply with the recommendations of NFPA 2001.

2 Documents certifying satisfactory system(s) operation shall be submitted to the Employer upon completion of each inspection.

8.3.8 Warranty

1 All system components furnished, and installed under this contract, shall be guaranteed against defects in design, materials and workmanship for the full warranty period which is standard with the manufacturer, but in no case less than one (1) year from the date of system acceptance.

8.3.9 Spare Parts

1 Hand over to the Employer the spare parts and tools required for operation and maintenance as recommended by the manufacturer to cover a working period of two years. In addition, submit to the Employer, for approval, a priced list of the above recommended spare parts and tools for an additional period of three years. The list should nominate the above required items. The approved list shall be part from the operation and maintenance manuals.
9. STEEL PIPE AND FITTINGS FOR FIRE PROTECTION SYSTEM

9.1 GENERAL

9.1.1 Related Documents

1 Drawings and general provisions of the Contract, including General Conditions, Conditions of Particular Application apply to work of this section.

9.1.2 Description of Work

1 This section specifies black or galvanized steel pipes, malleable iron fittings, welded fittings and grooved fittings as required by the Contract.

2 Extent of each type of steel pipes and fittings is indicated on drawings.

3 Steel pipes shall be installed and tested as part of the integrated fire protection systems.

9.1.3 Reference Standards

1 Unless otherwise more stringent requirements are specified throughout this section, steel pipe and fittings shall comply with the stipulations of the latest edition of the standard listed, the Qatar Construction specification rules and regulations guide for fire protection works or other equivalent International Standards and Sound Practice.

2 American Society for Testing and Materials

ASTM No.

(a) A 53 Welded and Seamless Steel
(b) A 181 Material for Carbon Steel Fittings
(c) A 197 Malleable Iron Fittings
(d) A 234 / A 234M Steel Fittings

3 American Society of Mechanical Engineers

ASME No.

(a) B 16.3 Malleable-Iron Screwed Fittings
(b) B 16.5 Cast-Steel Flanged Fittings
(c) B 16.9 Wrought-Steel Butt-Welding Fittings
(d) B 16.11 Forged-Steel Socket-Welding Fittings
9.1.4 Submittals

1 Submit the following in accordance with Conditions of the Contract and Division-1 Specification Sections:

(a) Materials specifications and manufacturer's data.
(b) Certificates of compliance.
(c) Installation structure and method of jointing.
(d) Representative samples of all pipes, fittings and accessories to be used in the work.
(e) Shop drawings.
(f) Post-installation test procedures.
(g) Maintenance data.

9.1.5 Quality Assurance

1 Inspection and Test by the Manufacturer: Pipe and fittings shall be thoroughly inspected by the manufacturer before delivery. The manufacturer shall make all tests as specified herein and the results of the tests shall be furnished to the Engineer upon request. The manufacturer may use his own or other suitable facilities for the performance of the inspection and test requirements specified herein. Fittings shall be suitably inspected for soundness and brittleness.

2 Testing: Materials and installed work may require testing and retesting at any time during the progress of the Works. Tests, including retesting of rejected materials or installed works, shall be done at the Contractor's expense.

9.1.6 Delivery, Storage and Handling

1 Handle pipes and fittings so as to prevent injury or damage to them. Place no pipe or other material inside any other pipe at any time.

2 Prevent pipe end damage and prevent entrance of dirt or debris.

9.1.7 Related Sections & Work

1 The following sections include requirements, which relate to this section:

(a) Section 23 Fire Protection Systems.
(b) Section 23 Clean Agent Fire Extinguishing System.

9.2 PRODUCTS

9.2.1 Materials

1 Steel Pipes: ASTM A 53, Schedule 40, Galvanized, seamless.
2 Steel pipes shall be tested for flatterting, bending, and internal hydrostatic pressure of 50 kg/cm² in accordance with the requirements of ASTM A 53.

3 Acceptable tolerances for thickness and weights shall not exceed those specified by ASTM A 53.

4 Fittings: Malleable iron threaded fittings, class 150 and 300 steel, conforming to ASME B 16.3.

5 Cast iron pipe flanges and flanged fittings, conforming to ASME B 16.1

6 Butt-welding fittings, conforming to ASME B 16.9

7 Socket-welding fittings, conforming to ASME B 16.11.

8 Fittings shall be hydraulically and mechanically tested in accordance with the requirements of the relevant standard.

9 Acceptable tolerances of diameters shall not exceed those specified by the relevant standards.

10 Roll grooved fittings and roll grooved couplings are acceptable methods. The roll grooved fittings and couplings shall be UL listed and FM approved for fire protection use.

9.3 EXECUTION

9.3.1 Installation, General

1 Installation of steel pipes and fittings shall comply with requirements of the Plumbing Specs Sections.

9.3.2 Joints Construction

1 Joints of steel pipes shall be by grooved coupling and fittings or screwed with threaded joints and fittings for 50 mm and less diameters above or below ground. Joints of steel pipes shall be by grooved coupling for diameters 65 mm and larger.

2 Threaded Joints: Tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:

(a) Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Align threads at point of assembly.

(b) Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is indicated elsewhere).

(c) Assemble joint and wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
3 Damaged threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

4 Flanged Joints: Flanged joints shall be furnished with bolts, nuts, gaskets and all necessary accessories. Bolts shall be of the best quality of steel with hexagonal head, washers and hexagonal nuts. Bolt lengths shall be so that, after erection, the bolt shall not protrude through the nut more than one to three threads. Gaskets shall be one piece, full face type of best quality cloth inserted sheet rubber at least 3 mm thick. Align surfaces of flanges parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

5 Coordinate flange standards with that of valves, pumps and equipment.

6 Welded Joints: Employ qualified welders and submit welders qualification certificate to the Engineer. Comply with the requirements of the ASME Boiler and Pressure Vessel Code. Submit welding procedures and the technical data and specification for electrodes.

7 Prepare end of parts to be welded in compliance with the joint design set up in the applicable welding-procedure specification.

8 Use proper machine tools for cutting. Thoroughly clean rust, scale, paint, oil or grease from welding faces and adjoining surfaces for a distance of 20 mm from edge of the welding groove or from the toe of the fillet in the case of socket-welded or fillet-welded joints. In addition, remove any contaminating or surface-coating material that may reach the weld area as a result of weld heat.

9 Layout and assemble various component parts. Carefully space, align and tack-weld together the parts to be jointed so that final welded assembly will conform to the required dimensions within acceptable tolerances (± 3 mm maximum end-to-end tolerance). Ensure that a sufficient number and suitable proportions of tack welds are provided to hold the parts in place during ordinary handling.

10 Apply sufficient number of weld passes to suit the material, thickness and position of parts to be welded. Start welding at the bottom and progress upward, except for thin-walled material.

11 Employ high degree of manual skill for downward welding to secure adequate fusion with sidewalls and to avoid entrapment of slag. Clean with wire brush each layer of deposited weld metal prior to the deposition of the following weld-metal layer. Chip or ground out surface defects which would otherwise affect the soundness of the weld. Remove bumps and sharp corners or grooves.

12 Roll groove Joints: Employ, qualified and well trained (by the manufacturer or his representative) personnel for preparing the pipe roll grooving.
13 Prepare end of pipes to be roll grooved in compliance with the coupling joint design and manufacturer requirements.

14 Use proper machine tools for roll grooving of pipes. Thoroughly clean rust or scale.

15 Use proper lubricant recommended by the manufacturer on the pipe before installing the gaskets.

16 Assemble various component parts with bolts and nuts only manufactured by the same coupling manufacturer.
SECTION 24

FINISHES TO BUILDING
1. GENERAL

1.1 INTRODUCTION

1.1.2 References

*Amend references to BS 1014 to be as follows respectively:*

- BS EN 12878 Pigments for Portland cement and Portland cement products.

*Amend references to BS 1230 to be as follows:*

- BS EN 520 Gypsum plasterboards. Definitions, requirements and test methods.

*Amend references to BS 6431 to be as follows:*

- BS EN ISO 10545 Ceramic Tiles

*Amend references to BS 4131 to be as follows:*

- BS EN 13748 Terrazzo Tiles

*Amend references to BS 5390 to be as follows:*

- BS 5628 Code of practice for the use of masonry Structural use of unreinforced masonry.
2 LATH AND PLASTER

2.1 GENERAL

2.1.1 Scope

*Add the following new paragraph:*

3 Type of plaster used in this project shall be as follows:

(a) Rendering with ordinary Portland cement mixes, two-coat work to receive painting finishes.

(b) Rendering for walls to have tile finish fixed with thin adhesive bedding will be one-coat with ordinary Portland cement.

(c) Rendering with ordinary Portland cement, one-coat work for walls to have tile finish fixed with thin adhesive bedding.

4 Stainless steel reveal for plaster grooves inlay.

2.1.2 References

*Add the following reference:*

BS EN 197-1 Cement. Composition, specifications and conformity criteria for common cements.

*Replace BS 1199 and BS 1200 with:*

BS EN 13139 Aggregates for mortar

*Replace BS 1014 with:*

BS EN 12878 Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test

*Replace BS 1369 with:*

BS EN 13658 Metal lath and beads.

*Replace BS 5492 with:*

BS EN 13914-2 Design, preparation and application of external rendering and internal plastering. Internal rendering

*Replace BS 5262 with:*

BS EN 13914-1 Design, preparation and application of external rendering and internal plastering. External rendering

*Replace BS EN 10142 with:*
Add the following new sub-clause:

2.1.3 Submittals

1 Product Data for each product specified.

2 Samples of each material, miscellaneous material and accessory to be used in the Works.

3 Field samples for verification at least 1200 mm square of each type of finish indicated; in sets for each colour, texture, and pattern specified, showing the full range of variations expected in these characteristics.

4 Certificate signed by manufacturer for each plaster material used certifying that materials comply with requirements.

2.5 METAL LATH

2.5.1 General

Delete in its entirety paragraphs and replace with the following new paragraph:

1 Expanded metal lath for use as reinforcement for plaster shall be diamond lath in coil or strip form manufactured of Stainless steel to comply with BS EN 10088 for internal use and stainless steel to BS EN 10088 for external use. Weight of expanded metal lath shall not be less than 1.11 kg/m². Width of coil or strip shall not be less than 200 mm. Prefabricated L-shaped pieces shall be used for corners. Maximum fixing centre will not exceed 300 mm.

2.7 BEADS AND STOPS

2.7.1 Materials

Delete in its entirety paragraphs and replace with the following new paragraphs:

1 Comply with material provisions of BS EN 13658 and requirements indicated in this clause; coordinate depth of accessories with thicknesses and number of plaster coats required.

   (a) Galvanised Steel Components: Fabricated from zinc-coated (galvanised) steel sheet complying with BS EN 10327-DX51D, minimum coating designation Z 180.

   (b) Metal Corner Reinforcement: Expanded, large-mesh, diamond-metal lath fabricated from welded-wire mesh fabricated from 1.2-mm- diameter wire and specially formed to reinforce external corners of Portland cement plaster on exterior exposures while allowing full plaster encasement.

   (c) Corner beads: Small nose corner beads fabricated from minimum 0.45 mm thick, with expanded flanges of large-mesh diamond-metal lath allowing full plaster encasement.
(d) Casing Beads and Grooves: Square-edged style, with expanded flanges of minimum 0.45 mm thick

(e) Control Joints: Prefabricated, of minimum 0.45 mm thick, One-piece-type, folded pair of imperforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.

(f) Expansion Joints: Folded pair of imperforated screeds in M-shaped configuration; with expanded flanges.

3 Lath Attachment Devices: Material and type recommended by lath manufacturer of same corrosion resistance standard as lath.

4 Stainless Steel Reveal for Plaster Grooves Inlay:

(a) Reveals shall be U-shaped sections formed by cold bending from stainless steel 304 sheets, 0.5 mm thick minimum.

(b) Finish: Satin.

(c) Furnish in lengths as long as practical.

(d) Dimensions are to be as indicated on Drawings/approved shop drawings.

(e) Drill for mounting screws 150 mm from ends of channels and not more than 600 mm o.c. Locate mounting screws at same heights for all channels.

2.7.2 Fixing Beads and Stops

*Add the following new paragraphs:*

3 Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Mitre or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and in alignment during plastering. Install accessories of type indicated on Drawings at following locations:

(a) External Corners: Install corner reinforcement at external corners.

(b) Terminations of plaster: Install casing beads, unless otherwise indicated.

4 Control Joints: Install at locations indicated or, if not indicated, at locations complying with the following criteria and approved by Engineer:

(a) As required to delineate plasterwork into areas (panels) of the following maximum sizes:

   (i) Vertical Surfaces: 13.4 sq. m.

   (ii) Horizontal and other Non-vertical Surfaces: 9.3 sq. m.

(b) At distances between control joints of not greater than 5.5 m o.c.

(c) As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.

(d) Where control joints occur in surface of construction directly behind plaster.
(e) Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

5 Grooves: Install to the panel indicated on Drawings or approved shop drawings.

2.9 PREPARATION OF SUBSTRATA

2.9.1 Preparation of Background to be rendered

Add the following new paragraphs:

6 Prior to applying any plaster coat, surfaces shall be thoroughly cleaned to remove dust, loose particles, foreign materials, oils, remains of wood forms. Use stiff brush as necessary, and reduce suction in plaster backgrounds by applying water in uniform rates.

7 Reinforcement to Service Chases: Where plastering crosses service chases and the like, cover chases with expanded metal strip fixed at not more than 600 mm centres along both edges.

8 Install plaster beads and stops as specified.

9 Refer to Section 18 “Carpentry, Joinery and Ironmongery” for installing permanent wood grounds, if any.

2.10 PREPARATION OF MIXES FOR RENDERING

2.10.1 Preparation Procedures and Selection of materials

Delete in its entirety paragraphs and replace with the following new paragraphs:

1 The terms “Render” and "plaster" are used equally in Contract Documents for exterior and interior cement-based coating (render). The specifications of “rendering" materials, preparation of backgrounds, fixing beads and stops, preparation of mixes, application of various coats; as included in the QCS specifications and these modifications shall be equally applied to all wall surfaces indicated on Drawings to be plastered or rendered.

2 Mixes for rendering below ground level that are in contact with soil shall be with sulphate resistant Portland cement if the soil report has recommended the same for foundation concrete.

3 Render work shall be two-coat work for render on solid wall backgrounds including block work and concrete and 3-coat work over metal lath. Overall thickness of internal render (plaster) coats shall be 15 mm and of external plaster shall be 20 mm, unless otherwise specified. Thickness of coats shall be as follows:

(a) Base Coat (undercoat): 10 – 12 mm.

(b) Finish (Final) Coat: 5 - 8 mm.

(c) For application on metal lath, a scratch coat as specified in this section
shall precede the two-coat work. Mix proportions for scratch coat shall be 300 Kg ordinary Portland cement to 1 m$^3$ sand.

(d) One plaster base coat for walls to be finished with ceramic tiles set with thin bed adhesive: 15 mm.

4 Cement sand proportions for render mixes shall be as follows, by volume:

(a) Base Coat (undercoat) for Internal Applications: Use 2-1/2 to 4 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

(b) Base Coat (undercoat) for External Applications: Proprietary pre-packaged blend of dry cementitious and other ingredients for mixing with polymer admixture to produce coating suitable for vertical applications behind Portland cement plaster.

(c) Finish (Final) Coat: Use 1-1/2 to 3 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

(d) Mix proportions and preparation for spatter dash keying shall be as specified in this Part.

5 Fibre for Base Coat: Alkaline-resistant glass or polypropylene fibres, 13 mm long, free of contaminants, manufactured for use in Portland cement plaster.

2.10.2 Application of the Various Render Coats

Add the following new paragraphs:

13 Apply plaster materials, composition, and mixes to comply with BS EN 13914-2 and BS 8000: Part 10 for internal plastering, and BS S EN 13914-1 and BS 8000: Part 10 for external plastering.

14 Flat Surface Tolerance:

(a) Sudden irregularities are not permitted.

(b) Deviation of plaster surface to be measured from underside of a straight edge placed anywhere on surface.

(i) Permissible deviation (maximum) of internal plaster: 3 mm in any consecutive length of 1800 mm.

(ii) Permissible deviation (maximum) of external plaster: 3 mm in any consecutive length of 2 m.

15 Smooth finish for render or plaster to receive painting shall be by trowelling or floating to produce a tight, matt, smooth surface with no hollows, abrupt changes of level or trowel marks. Do not use water brush and avoid excessive trowelling and over polishing.

16 Surface of coats to receive tile finish should be combed with evenly spaced wavy horizontally lines. The lines are to be approximately 20 mm apart and 5 mm deep.
2.11 PORTLAND CEMENT PLASTER

2.11.1 Materials

*Delete in its entirety paragraphs and replace with the following new paragraphs:*

1. Cement BS EN 197-1:
   (a) Types: Portland cement, CEM I

2. Sand: BS EN 13139.
   (a) Grading: 0/2 or 0/4 (CP or MP); category 2 fines.
   (b) Colour and texture to be consistent


4. Admixtures: Air entraining (plasticising) admixtures: To BS EN 934-2, compatible with other mortar constituents.
   (a) Prohibited Admixtures: Calcium chloride and any admixtures containing calcium constituents

5. All render mixes shall be cement-sand mixes. Use of lime is not permitted. Approved liquid-type admixture that replaces the effect of lime in the mix can be used to the instructions of the manufacturer. Do not use calcium chloride or any admixtures containing calcium chloride.

6. Water shall comply with the requirements of BS EN 1008.

2.12 TABLE PIGMENTS FOR CEMENT

2.12.1 Materials

*Amend reference standard in paragraph number 1 to be to BS EN 12878.*
3. DRY LINING (WALLBOARD)

3.1 GENERAL

3.1.1 Scope

2 Related Parts and Sections are as follows:

Add the following and the end of Sub-Clause 2

Section 26 Painting and Decoration

Add the following new sub-clause numbered 3.1.3 through 3.1.4:

3.1.3 Submittals

1 Shop Drawings: provide co-ordination, fabrication and installation drawings and other information showing such details of the work as the Engineer may reasonably require.

2 Samples: before placing orders submit representative samples of all types of framing and furring members and gypsum plasterboard materials. Ensure that delivered materials match samples.

3 Control Samples: for each type of plasterboard assembly: lining, partition and ceiling, erect and complete an area of finished work not less than 10 m² in an approved location and obtain approval of appearance before proceeding.

4 Laboratory test reports and manufacturer’s certificates that substantiate compliance of proposed gypsum board walls, partitions, linings enclosures, and protection or shaft walls with performance requirements indicated on Drawings or specified in this Section.

3.1.4 Quality Assurance

1 Single Source Responsibility: provide studs, furring, fasteners accessories, finishing materials and generally all materials and components of plasterboard linings, partitions and ceilings from the manufacturer of plasterboards.

2 Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 or by UKAS for testing indicated.

3 Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to BS 476 20 by an independent testing and inspecting agency acceptable to the Engineer.

4 Sound Transmission Characteristics: For gypsum board assemblies with acoustical ratings indicated on Section 07, provide materials and construction identical to those tested in assembly indicated according to BS EN ISO 717-1.

5 Gypsum Board Finish Mock-ups: Before finishing gypsum board assemblies, install mock-ups of at least 9 sq. m in surface area to demonstrate aesthetic
effects and qualities of materials and execution.

(a) Install mock-ups for the following applications:
   (i) Surfaces with finishes.
(b) Apply or install final decoration indicated, including painting and wall coverings, on exposed surfaces for review of mockups
(a) Simulate finished lighting conditions for review of mockups.
(b) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion

6 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.
(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer

3.2 DRY LININGS

3.2.1 Materials

Replace Paragraph no. 1 with the following:

1 Gypsum wallboard is to be not less than 15 mm thick gypsum plasterboards complying with BS EN 520. Type of gypsum plasterboards are to be as follows according to applications:

(a) Type A: Regular boards.
(b) Type H1: Moisture resistance boards for applications in wet areas and where indicated on Drawings.
(c) Type F: Fire improved boards for fire rated applications.
(d) Weight: Not less than 9.8 kg/m².

2 Cement Board Generally: Cementitious, water durable, surfaced with fiberglass reinforcing mesh, complying with ANSI A118.9 and ASTM C 1325, suitable for exterior applications.

(a) Long Edges: Wrapped.
(b) Thickness: 13 mm, unless otherwise indicated on Drawings.
(c) Water Absorption: 10% maximum, according to ASTM C473.
(d) Flexural Strength: 5 MPa, according to ASTM C947.
(e) Surface Burning Characteristics: According to E84.
   (i) Smoke index: 0
   (ii) Flame spread index: 5
Delete sub-Paragraph (b) & (C)in Paragraph 3

Add the following new clauses:

3.2.3 Sections

1 Studs and Furring: Shall be made from galvanized mild steel sheet to BS EN 10143, 100 gm/m² zinc coating intensity at each face of sheets. Sheet thickness is to be not less than 0.55 mm for studs up to 3600 mm high, channels and furring and not less than 0.70 mm for studs up to 4200 mm high. Profiles are to be to the requirements of BS 7364.

3.2.4 Core Insulation

1 Mineral Fibre Insulation: Prefabricated thermal insulation combining mineral fibres manufactured of Rockwool or Glass wool with thermosetting resins to comply with BS EN 13499, blankets without membrane facing, intensity as required to achieve fire or sound rating specified but not less than 48 to 50 kg/m³. Free CFCs, HCFCs and any other material with ozone depletion potential in its manufacture and content and presents no known threat to the environment. Insulation is to be designed to fit snugly into steel stud cavities of partitions and dry linings and will not sag or slump in wall cavities.

   (a) Thickness of boards: As indicated on the Drawings or approved shop drawings.

   (b) Fire Classifications: Euroclass A1 to BS EN 13501-1.

2 Furnish core insulation produced by gypsum board manufacturer or by a manufacturer recommended in writing by gypsum board manufacturer and that is classified as non-combustible.

3 For fire rated assemblies, core insulation fire rating shall be tested to BS 476: Part 20/22 or other equivalent international standard acceptable to the Engineer.

3.2.5 Fixing, Jointing and Finishing Materials and Accessories

1 Generally: Fixing, jointing and finishing materials and accessories, where not otherwise specified, are to be as produced or recommended for particular purpose and application by plasterboard manufacturer.

2 Screws: Zinc or cadmium plated self-drilling and tapping screws with countersunk heads, size as recommended by manufacturer.

3 Jointing Compounds for plasterboard are to be proprietary drying-type factory-packaged vinyl-based factory-mixed products complying with specified requirements for formulation and intended use.

4 Joint Compound for Exterior Applications:

   (a) As recommended by manufacturer.

5 Joint Tapes: are to be pressure sensitive or staple attached proprietary reinforcing tapes, compatible with and as recommended for particular purpose
and application by jointing compound manufacturer workmanship

3.3  FIXING OF WALLBOARD

3.3.1 Fixing Wallboard to Framed Backgrounds

*Add the following new paragraph*

7  Installation Standards:  BS EN 520, and BS 8000 requirements that apply to framing installation.

8  Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

9  Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.

10 Isolate ceiling assemblies where they abut or are penetrated by building structure.

   (a) Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.

11 Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

12 Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

   (a) Cut studs 13 mm short of full height to provide perimeter relief.

   (b) For fire-resistance-rated and $R_w$-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.

      (i) Terminate partition framing at suspended ceilings where indicated.

13 $R_w$-Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
14 Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 6.4- to 12.7-mm wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

15 Single-Layer Application:
(a) On partitions/walls, apply gypsum panels vertically (parallel to framing, unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
(b) Single-Layer Fastening Methods: Apply gypsum boards to supports with steel drill screws.

16 Multilayer Application on Partitions/Walls:
(a) Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
(i) Z-Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

17 Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.

Add the following new clauses:

3.3.4 Installation References, Generally
1 Comply with the following:
(a) BS 8212 for installing furring or studs of dry lining system.
(b) Manufacturer’s recommendation and printed instructions, unless more stringent requirements are specified in referenced standards, indicated on Drawings or specified in this Section.
(c) Drawings and approved shop drawings.

3.3.5 Walls and Partitions
1 Provide assemblies that are tested or listed by a testing and inspection agency acceptable to the Engineer as satisfactory for performance requirements indicated on Drawings or specified in this Section.
2 Walls and partitions are to be non-loadbearing, partitions to details and heights indicated on Drawings and are to comply with the following requirements:
Construction: Minimum no. of skins to be as indicated on Drawings to achieve performance requirements, fixed to galvanised steel studs, runners and furring with insulation blankets as specified inserted into the cavity of the steel studs.

Additional Struts, Noggings and the like: Provide as recommended by manufacturer as required to comply with openings indicated on Drawings and as required to fix equipment, fittings and the like indicated to be fixed to assemblies.

Thickness: Overall thickness to be as indicated on Drawings and approved shop drawings to achieve performance requirements indicated.

Fire Resistance Rating: As indicated on Drawings.
Acoustic Rating Refer to Section 07
Acoustic beads Manufacturer’s standard.
Acoustical sealant: As specified in this Section.

3.3.6 Horizontal Joints

1 Joints will not be permitted in partitioning or wall linings except where heights exceed maximum available length of board. Agree positions of joints where not specified.

3.3.7 Taped Seamless Finish

1 Lightly sand cut edges of boards to remove paper burrs; apply sealer compatible with finish coat to exposed cut edges of boards to which tape is to be applied.

2 Fill all joints and gaps and cover with continuous lengths of tape, fully bedded; when set, cover with joint finish, feathered out to give a flush, smooth, seamless surface; apply two coats of joint finish at external angles.

3 Spot nail and screw depressions with joint filler and when set apply a continuous overall coat of joint finish, feathered off to give a flush, smooth surface.

4 Fill minor indents and, after joint, angle and spotting treatments have dried, apply surface finish slurry to give a continuous, consistent texture to surface.

3.3.8 Finishing Gypsum Board Assemblies

1 General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

2 Prefill open joints, rounded or bevelled edges, and damaged surface areas.

3 Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
4  Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface

3.3.9  Cabinet Partitions

1  Install Plywood Backing Between the profiles
2  Fix The Plywood on one side With L angle
3  Screw Spacing : min 100 mm
4  The Plywood backing should be wider than total of the object
5  Space stud at max 600 mm centres
6  Extra stud should be at openings, corners and stop ends

3.3.10  Resin Panel

1  Panels are produced from polyester-based material.
2  Tested and meets the criteria for approved “Light transmitting Plastic” as described in the IBC and also has a Class B rating for flame spread as characterized by ASTM E 84 or UL 723.
4 SPECIAL WALL SURFACES

Add the following new paragraph:

4.3 VINYL WALL COVERING

4.3.1 General

Provide rolls of each type of wall covering from the same run number or dye lot.

1 Sheet Width: 130 cm, min.

2 Weight: 355 gm/m2.

3 Comply with BS 476 Class 1 & 0.


5 Light Fastness: ≥ 7 according to International Wool Scale.

6 Colors, Textures, and Patterns: As selected by Engineer.
5. TILE

5.1 GENERA

5.1.2 References

Delete second and third references in list of references and replace with:

- BS EN 12004 Adhesives for tiles. Definitions and specifications
- BS EN 14411 Ceramic tiles. Definitions, classification, characteristics and marking

Amend list of references to read as follows:

- British Standards Institute (BSI) - UK
- BS 5385-1 Wall and floor tiling. Code of practice for the design and installation of internal ceramic and natural stone wall tiling and mosaics in normal conditions
- BS 5385-3 Wall and floor tiling. Code of practice for the design and installation of ceramic floor tiles and mosaics
- BS EN ISO 10545 Ceramic Tiles

Add the following new sub-clauses:

5.1.3 Submittals

1 Product Data: For each type of tile, adhesive, mortar, grout, and other products specified, including printed statement of VOC content and material safety data sheets.

2 Shop Drawings: For the following:

   (a) Tile patterns and locations.
   (b) Widths, details and locations of perimeter and intermediate movement joints in tile substrates and finished tile surfaces.

3 Tile Samples for Initial Selection: Manufacturer's colour charts consisting of actual tiles or sections of tiles showing the full range of colours, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving colour selection.

4 Samples for Verification: Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal colour and texture variations, include Sample sets showing the full range of variations expected.

   (a) Each type and composition of tile and for each colour and texture required, at least 300 mm square, mounted on braced cementitious backer units, and with grouted joints using product complying with specified requirements and approved for completed work in colour or colours selected by Engineer.
(b) Full-size units of each type of trim and accessory for each colour required.
(c) Metal edge strips in 300-mm lengths.
(d) Movement joint systems in 300-mm lengths.

5 Product Certificates: Signed by manufacturers certifying that the products furnished comply with requirements.

6 Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names of Engineers and owners, and other information specified.

7 Tile Test Reports: Indicate and interpret test results for compliance of tile with specified performance requirements.

8 Setting and Grouting Material Test Reports: Indicate and interpret test results for compliance of tile-setting and -grouting products with specified requirements.

5.1.4 Quality Assurance

1 Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

2 Source Limitations for Tile: Obtain each colour, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.

3 Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

4 Source Limitations for Other Products: Obtain each of the following products specified in this Section from one source and by a single manufacturer for each product:

(a) Movement joint systems
(b) Joint sealants.
(c) Waterproofing.

5 Mock-ups: Before installing tiles, construct mock-ups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated for completed Work.

(a) Locate mock-ups in the location and of the size as selected by the Contractor and approved by Engineer.
(b) Notify Engineer 7 days in advance of the dates and times when mock-ups
will be constructed.

(c) Demonstrate the proposed range of aesthetic effects and workmanship.

(d) Obtain Engineer's approval of mock-ups before proceeding with final unit of Work.

(e) Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.

(f) Approved mock-ups in an undisturbed condition, as judged by the Engineer, at the time of substantial completion of ceramic tile works may become part of the completed Works, otherwise the Contractor shall demolish, remove from site mock-ups and install permanent works.

6 Environmental Limitations: Do not install tile until construction in spaces is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

7 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

5.1.5 Delivery, Storage and Handling

1 Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.

2 Prevent damage or contamination to materials by water, foreign matter, and other causes.

3 Handle tile with temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

5.2 TILES ADHESIVES

5.2.1 Adhesive Types

Replace Paragraph no. 1 with the following new paragraphs:

1 Adhesive Fixing: Shall comply with Section 7 requirements and the following:

   (a) Reference: BS EN 12004

   (b) Type: C (Cementitious Adhesive).

   (c) Class: 1
5.3 CERAMIC TILES

5.3.1 General

Add the following new paragraph:

3 Paver floor tiles shall be with surface treatments to reduce the possibility of slipping.

5.3.2 Glazed Ceramic Wall Tiles

Delete in its entirety paragraph and replace with the following:

1 Ceramic wall tiles and fittings for interior use shall comply with BS 5385 and requirements specified in Drawings and the following requirements:

(a) Water Absorption: 3 %≤ E ≤ 6% (Group BIIa).
(b) Thickness: Minimum 6.00 mm.
(c) Face: Plain with modified square edges or cushion edges
(d) Surface Finish: Glazed

2 All ceramic wall tiles shall be of glazed finish. Back of tiles shall be keyed.

3 Size will be as indicated on Drawings. Thickness shall not be less than 6 mm. Colour and pattern shall be as selected by the Engineer from manufacturer's full range if not indicated on Drawings.

4 Use coloured PVC beads.

5.3.3 Fixing Internal Ceramic Wall Tiles

Amend paragraph no. 3 for the rendering thickness to be 15 mm of similar mix of base coat.

Amend paragraph no. 9 to read as follows:

9 Movement joints not less than 6 mm and not more than 10 mm are to be provided in compliance with requirements of referenced BS Standard.

Amend paragraph no. 15 to read as follows:

15 Joints between tiles are to be to details indicated on drawings and approved mock-ups.

Add the following new paragraph:

17 Set and grout ceramic mosaics with cement-adhesive setting adhesive and grout material on 15 mm thick coat of cement sand plaster of mix proportion similar to that specified for Portland cement plaster base coats in this Section Part "Lath and Plaster" applied onto scratch coat.
5.3.5 Floor Tiles

Delete in its entirety paragraphs and replace with the following new paragraphs:

1 Paver floor tiles and fittings, ceramic mix for interior use shall comply with BS EN 14411 Group Al, E <3%.
   (a) Paver floor tiles shall be with surface treatments to reduce the possibility of slipping and with unglazed finish.
      (i) Rating (R): R10, according to DIN 51130.
      (ii) Class (A) for wet areas according to DIN 51097.
      (iii) Thickness: Minimum 8.00 mm.
   (b) Back of tiles shall be keyed.
   (c) Colour: Shall be selected by the Engineer from manufacturer's full range, if not indicated on drawings.
   (d) Facial Dimensions: As indicated on Drawings.
   (e) Face: Plain with square or cushion edges.

2 Unglazed Porcelain Floor Tiles: Provide flat tile complying with BS EN 14411 Group Bla and the following requirements:
   (a) Composition: Porcelain mix.
   (b) Water Absorption: Less than 0.5%
   (c) Surface Finish: As indicated on Drawing.
   (d) Facial Dimensions: As indicated on Drawings.
   (e) Thickness: minimum 9.0 mm
   (f) Face: Plain with square or cushion edges
   (g) Non-Slip treatment: Provide for all ceramic floors installed in wet areas similar to toilets

3 Wall Tile: Provide tile complying with the following requirements:
   (a) Composition: Porcelain mix, fully vitrified.
   (b) Constriction: Color-through.
   (c) Surface Finish: Glazed or matt as indicated on Drawing.
   (d) Facial Dimensions: As indicated on Drawings.
   (e) Thickness: 9.0 mm, minimum.
   (f) Face: Plain with square or cushion edges.

3 Unglazed Floor Heavy-Duty Ceramic Tiles (Quarry Tiles): Square edged tile formed from natural clay or shale by extrusion process and comply with Group A1 of BS EN 14411 and the following requirements:
(a) Size: As indicated on Drawings.
(b) Face: Plain.
(c) Thickness: Minimum 13.00 mm for tiles.
(d) Colour: Shall be selected by Engineer from manufacturer’s full range if not indicated on drawings.
(e) Water Absorption: Less than 3% to BS EN ISO 10545-3.
(f) Abrasion Resistance: Less than 100 mm$^3$ to BS EN ISO 10545-6.
(g) Staining Resistance: Class 5.
(h) Slip Resistance: R 11-R 13 according to BS EN ISO 10545-14.
(i) Scratch Hardness: > 7 Mohr’s scale.
(j) Chemical Resistant: According to BS EN ISO 110545-13
   (i) Household Chemicals: Class UA (no visible affect)
   (ii) Low concentration acids Class ULA (no visible affect)
   (iii) High concentration acids: Class UHA (no visible affect)

4 Fixing of paver floor tiles shall be by semi dry mix method or by direct mortar bedding method as specified in QCS and these amendments.

5.3.8 Ceramic Mosaic Tiles

1 Ceramic Mosaics: Are to be 4 mm thick ceramic mosaics with plain surface, modified cushion edges factory-mounted-and-bonded into sheets with acid/alkaline-resistant material that provides excellent bonding to substrates.

2 Size: As indicated on Drawings

3 Ceramic mosaics are to be of unglazed surface finish manufactured of dry-pressed natural clay kiln-fired to vitrification to obtain glazed surface. Water absorption is to be less than 3%.

4 Colour shall be as indicated on Drawings.

5.3.9 Laying Ceramic Floor Tiles by the Thin Set Adhesive

1 Provide concrete substrates for tile floors installed with adhesive that comply with flatness tolerances specified in referenced BS 5385.

(a) Fill cracks, holes, and depressions with trowelable levelling and patching compound according to tile-setting material manufacturer’s written instructions. Use product specifically recommended by tile-setting material manufacturer.

(b) Remove protrusions, bumps, and ridges by sanding or grinding.

2 Comply with BS 5385 and manufacture written recommendations.

3 Back Buttering: Obtain 100 % mortar coverage by complying with applicable
special requirements for back buttering of tile in referenced

4 Flexible (Control) Joint Systems: shall be pre-fabricated, heavy-duty EPDM rubber section reinforced with stainless steel angles and confirming to the requirements of BS 5385. Select depth of section to comply with depths of tiles or pavers and bedding according to manufacturer's details.

5 Grouting: Comply with BS EN 13888.

5.3.10 General Requirements for Ceramic Tile Installation

1 Examination: Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

   (a) Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced tile installation standards for installations indicated.

   (b) Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile have been completed before installing tile.

   (c) Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust latter in consultation with Engineer.

   (d) Do not proceed with installation until unsatisfactory conditions have been corrected.

2 Install waterproofing to comply with requirements of manufacturer's written instructions to produce a waterproof membrane of uniform thickness bonded securely to substrate. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3 Remove coatings, including curing compounds, and other substances that contain wax, oil, or silicone and are incompatible with tile-setting materials by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.

4 Floor Movement Joints: shall be as defined in BS 5385 Part 3, including structural movement joints (expansion joints), perimeter and intermediate flexible joints.

   (a) Joint system for intermediate flexible and control joints shall be prefabricated joint system as specified in this Section.

   (b) Joints system for perimeter joints shall be sealant filled system as specified in Part 10 "Joint Caulking and Sealants" of this Section.

   (c) Locate movement joints as per requirements of BS 5385: Part 3 and as indicated on approved shop drawings.

   (d) Install movement joint systems so as top surface of angle frames is flush with adjoining tiles at floor level finish indicated on Drawings.

5 Wall Movement Joints: Comply with requirements of BS 5385: Part 1. Joint
systems to be sealant filled joint.

6 Field-Applied Temporary Protective Coating: Protect exposed surfaces of tile against adherence of mortar and grout by pre-coating them with a continuous film of temporary protective coating from one of those indicated below, taking care not to coat unexposed tile surfaces:

(a) Petroleum paraffin wax, applied hot.
(b) Grout release.
(c) Petroleum paraffin wax or grout release.

7 Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

8 Comply with BS 5385; Part 1 for internal wall installations, Part 3 for floor installations and Part 4 for installations within water tank.

9 Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

10 Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

11 Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are the same size. Lay out tile work and centre tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated. Align joints in walls and floors to the maximum possible extent.

12 Lay out tile wainscots to next full tile beyond dimensions indicated.

13 Stone Thresholds: Install stone thresholds at locations indicated; set in same type of setting bed as abutting field tile, unless otherwise indicated.

14 Grouting: Grout tile to comply with the requirements of appropriate parts of BS 5385.

15 Slope tile surfaces uniformly to drains.

16 Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter. Remove latex-Portland cement grout residue from tile as soon as possible. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Protect metal surfaces, cast iron, and vitreous plumbing fixtures from effects of acid cleaning. Flush surface with clean water before and after cleaning. Remove temporary protective
coating by method recommended by coating manufacturer that is acceptable to brick and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

17 Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure tile is without damage or deterioration at the time of Taking Over by the Employer. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with Kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. Prohibit foot and wheel traffic from tiled floors for at least 7 days after grouting is completed. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

5.3.11 Grouting

1 Shall comply with the following:

(a) Reference: BS EN 13888
   (i) In wet areas
      1) Type: R
      2) Resistance to Mould and Fungus.
   (ii) In Other areas
        1) Type: C
7. NATURAL STONE FLOORING

7.1 GENERAL REQUIREMENTS

7.1.1 Scope

*Amend paragraph no. 1 to be as follows:*

1 This Part specifies requirements for interior and exterior stone paving, set in mortar on a rigid base.

*Add the following to the list of Related Sections at the end of paragraph 2:*

Section 17 “Metalwork “.

7.1.2 References

*Add the following list of references:*

- BS 5385-5 Wall and floor tiling. Code of practice for the design and installation of terrazzo tile and slab, natural stone and composition block floorings
- BS 8000-11.2 Workmanship on building sites. Code of practice for wall and floor tiling. Natural stone tiles
- BS EN 12004 Adhesives for tiles. Definitions and specifications
- BS EN 12058 Natural stone products. Slabs for floors and stairs. Requirements
- BS EN 12878 Pigments for the colouring of building materials based on cement and/or lime. Specifications and methods of test
- BS EN 13139 Aggregates for mortar

7.1.4 Submittals

*Add the following at the end of sub-paragraph in paragraph no. (a):*

“Samples shall be 300 mm square. After selection of stone types by the Engineer, the Contractor shall submit five samples of each selected type in full size of units required for flooring or patterns to verify selection made. Samples shall have surface finish same as specified for the works in this Section.”

*Add the following at the end of sub-paragraph in paragraph no. (b):*

“Shop drawings shall indicate details of all floorings, dimensions of units and joints and installation details”

*Add the following Sub-paragraphs:*

(c) Product Data: For each type of natural stone proposed for use in flooring or flooring patterns.

(d) Product Data: For each type of material used in the works of this Section.
7.1.5  Product Delivery, Storage and Handling

*Add the following new paragraphs:*

3 The Contractor shall take great care during construction to ensure that damage arising from site handling, erection, protective devices, levering, wedging and adjustment does not occur.

4 Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp. Cement shall be stored as specified in Section 5 of the QCS “Concrete”.

*Add the following new sub-clauses:*

7.1.6  Quality Assurance

1 Installer Qualifications: A qualified installer who employs workers for this Project those are competent in stone flooring and patterns installations.

2 Source Limitations for Stone: Obtain each type of stone, regardless of finish, from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.

4 Source Limitations for Other Materials: Obtain each type of cementitious material, grout, admixture, stone accessory, sealant, and other material from a single manufacturer.

6 Matching: All stone flooring shall be dry matched prior to fixing with mortar.

7.1.7  Hot-Weather Requirements

1 Maintain temperature of materials below 38 deg C.

2 Do not apply mortar to substrates with temperatures of 38 deg C and above.

3 When the ambient temperature exceeds 32 deg C, fog spray installed stone paving until damp at least 3 times a day until paving is 3 days old.

7.2  MATERIALS

7.2.1  General

*Delete in their entirety content and replace with the following:*

1 Natural stone units used in the works shall be sawed, cut, split and finished to shapes, dimensions and patterns indicated on Drawings with true, clean, neat, sharp edges; straight, unless otherwise indicated on Drawings. Units shall be uniform in shape and thickness. Units that are warped, broken, spalled, stained or otherwise defective will not be acceptable.

   (a) Provide stone from a single quarry for each variety of stone required.

   (b) Provide matched blocks extracted from contiguous locations in a single bed of quarry stratum unless stone from blocks randomly selected for aesthetic
effect is approved by Engineer.

2 Stone:
   (a) Type: As indicated on Drawings.
   (b) Colour: As indicated on the drawings.
   (c) Contractor should submit to the approval of the Engineer test reports that demonstrate compliance of used natural stone supplies with reference specified before.

3 Bases shall be cut to lengths to the Engineer’s approval. Provide special units to suit end and edge situations.

4 Stone Finishes shall be as follows:
   (a) Honed Finish: Grind in the workshop to a low lustre without reflections.
   (b) Polished Finish: Grind exposed surfaces and edges in the workshop to a high lustre with reflections.
   (c) Extent of each finish will be as indicated on Drawings.

5 Exposed edges and rebates shall be finished to match stone surface.

7.2.2 Other Materials

Replace paragraph no. 3 with the following:

3 Mortar Pigments: BS EN 12878, natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in stone mortars.

Add the following new paragraph:

4 Water: Potable.

7.2.3 Mortar

Add the following new paragraphs:

2 Sand: BS EN 13139
   (a) Grading: designation: 0/4 (MP) category 1 fines and between 20% -66% passing 0.5 sieve

3 Latex additive (water emulsion) shall be styrene butadiene rubber, serving as replacement for part or all of mixing water, of type specifically recommended by latex additive manufacturer for use with job-mixed Portland cement and aggregate mortar bed.

4 Batch by volume.

5 Mix materials thoroughly to uniform consistence. Use a suitable forced action
mechanical mixer. Do not use a free fall type mixer

6 Latex-Modified-Portland Cement Setting-Bed Mortar: Comply with ANSI A118.4

(a) Mixture of prepackaged dry-mortar and styrene-butadiene-rubber liquid-latex additive.

7.2.4 Grout

Replace paragraph no. 1 with the following new paragraphs:

1 Grout shall be mixture of factory-prepared, dry-grout mix and latex additive. Comply with requirements of EN 13888, type R.

2 Grout mix:

(a) Cement: shall be BS EN 197-1, ordinary Portland type CEM I/42.5

(b) Sand:

(i) Joint widths of 6 mm or greater: To BS 1199, table 1, Type B.

(ii) Joint widths of 3-6 mm: To BS 5385-5, table 2.

(c) Pigments: BS EN 12878, limited to 5-10% of the cement content

(i) Staining of tiles is not permitted.

(d) Proportions (cement: sand):

(i) 2–3 mm wide, use 1:1.

(ii) 3–6 mm wide, use 1:2.

(iii) Above 6 mm wide, use 1:3.

(e) Latex Additive shall be styrene-butadiene rubber.

7.3 EXECUTION OF WORK

7.3.2 Application

Replace paragraphs no. 2 and 3 with the following new paragraphs:

2 Examine surfaces indicated to receive stone paving and flooring, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance.

3 Sweep substrates to remove dirt, dust, debris, and loose particles. Remove substances from substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance. Clean dirty or stained stone surfaces by removing soil, stains and foreign materials before setting. Clean stone by thoroughly scrubbing with fibre brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

4 Comply with requirements of BS 8000-11.2 and BS 5385-5. Do necessary field cutting as stone is set. Use power saws with diamond blades to cut stone. Cut
lines straight and true, with edges eased slightly to prevent snipping. Set stone to comply with Drawings and Shop Drawings approved by the Engineer. Match stone for colour and pattern by using units numbered in sequence as indicated on Shop Drawings. Scribe and field-cut stone as necessary to fit at obstructions. Produce tight and neat joints.

5. Remove and replace broken, chipped, stained, or otherwise damaged stone.

6. Replace in a manner that result in stonework matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.

7. Clean stonework as work progresses. Remove mortar fins and smears before tooling joints.

8. Prohibit traffic from installed stone for a minimum of 72 hours.
9. FLOOR SCREEDS AND TREATMENTS

9.1 GENERAL

9.1.1 Scope

Amend paragraph 1 to read as follows:

1 This Section specifies cement-based floor screeds of the following types:
   (a) Normal-weight-aggregate levelling screeds to attain required levels under floor finishes and roofing.
   (b) Self-levelling screeds to attain required levels under carpets and vinyl floorings.
   (c) High performance epoxy coating for service rooms.

Add the following parts in paragraph 2 as related parts:

Part 10 Joints, Caulking and sealants.

9.1.2 References

Add the following Standards

BS 4551-1 Methods of testing mortars, screeds and plasters. Physical testing.
BS 8204-1 Screeds, bases and in-situ floorings. Concrete bases and cement sand levelling screeds to receive floorings. Code of practice
BS EN 197-1 Cement. Composition, specifications and conformity criteria for common cements
BS EN 934-3 Admixtures for concrete, mortar and grout. Admixtures for masonry mortar. Definitions, requirements, conformity, marking and labelling.
BS EN 1015 Methods of test for mortar for masonry.

Add the following new sub-clauses:

9.1.3 Submittals

1 Product Data: For each material product included or used.
2 Mix Design and Test Reports: For each mix used for screeds.
3 Joint details and arrangements.
4 Test reports for field quality control testing.
5 Samples for Initial Selection: Manufacturer’s colour charts showing the full range
of colours, textures, and patterns available for each floor treatment system indicated.

6  Samples for Verification: Of each floor treatment system required, 150 mm square, applied by Installer for this Project to a rigid backing, in colour, texture, and finish indicated. Where finishes involve normal colour and texture variations, include Sample sets showing the full range of variations expected.

7  Material Test Reports: From a qualified independent testing agency indicating and interpreting test results of the floor treatment reaction to chemicals and other reagents and substantiating compliance with requirements.

8  Maintenance Data: For floor treatment system.

9.1.4  Quality Assurance

1  Installer Qualifications: A qualified firm specializing in performing the work of this Section with minimum three years documented experience and that is approved, authorized, or licensed by the product manufacturer to install his product.

2  Source Limitations: Obtain primary floor treatment system materials, including primers, resins, hardening agents, and sealing or finish coats, through one source from a single manufacturer. Provide secondary materials including patching and fill material, joint sealant, and repair materials of type and from source recommended by manufacturer of primary materials.

3  Apply mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

   (a)  Apply full-thickness mock-ups on 1200-mm square floor area selected by Engineer. Include 1200-mm length of integral cove base.

   (b)  Simulate finished lighting conditions for Architect's review of mock-ups.

   (c)  Approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

4  Obtain Engineer’s approval of mock-ups before applying floor treatment. If field samples are unacceptable, make adjustments to comply with requirements and apply additional samples until field samples are approved. After field samples are approved, these surfaces will be used to evaluate floor treatment.

5  Coordinate cement-based screed with requirements of finish flooring products, including adhesives.

6  Document Conflict and Precedence:

   (a)  Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

   (b)  The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.
9.1.5 Delivery, Storage and Handling

1 Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

2 Store loose materials in a manner to prevent intermixing.

3 Store packaged materials to comply with manufacturer's written instructions to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

9.1.6 Project Conditions

1 Environmental Limitations: For proprietary products, comply with manufacturer's written recommendations for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting screed or treatment performance.

2 Close areas to traffic during screed application and for appropriate time period after application as recommended in writing by manufacturer.

9.2 PREPARATION AND PROCEDURES

9.2.1 Cement and Sand Floor Screeds

Delete in its entirety content and replace with the following:

1 Examine substrates, with Installer present, for conditions affecting performance of screed. Proceed with application only after unsatisfactory conditions have been corrected. Verify that base slabs meet finish and surface profile requirements in BS 8204-1.

2 Prepare substrate to receive cement-based screeds in strict accordance with requirements of BS 8204-1.

3 Joint Fillers: Install joint-filler strips where screed abuts vertical surfaces, such as column pedestals, foundation walls, grade beams and other locations, as indicated.

(a) Extend joint-filler strips full width and depth of joint, terminating flush with screed surface, unless otherwise indicated.

(b) Terminate full-width joint-filler strips 13 mm below screed surface where joint sealants specified in Part 10 "Joints, Caulking and Sealants" are used.

(c) Install joint-filler strips for perimeter in lengths as long as practicable. Where more than one length is required, lace or clip sections together. Install joint filler full depth of joints.

4 Flexible Joints: Locate intermediate movement joints to comply with requirements of Specification Section covering finish layer to overlay screed or to produce bays unless otherwise recommended in BS 8204-1, not more than 15.00 square meters in plan; with a ratio of length to width not more than 3:2 and a joint
occurring over every joint in base slab.

Add the following new sub-clause:

### 9.2.2 Mixing

1. Mix bonding slurry according to manufacturer's written instructions to a thick paint consistency.

2. Levelling Screed Mix: Design mix, with or without admixture, to produce screed of In Situ Crushing Resistance category A and the following characteristics:
   
   (a) Compressive strength at 28 days: Not less than 25 MPa to BS EN 1015
   (b) Slump: maximum 125 mm
   (c) Flexural Strength: 2.0 N/mm².
   (d) Density: 1500 kg/m³, minimum.

3. For levelling screeds 70 mm and more in depth, use fine concrete screed with minimum cement content of 350 kg/m³.

4. Reinforcement: Fibremesh as specified. Add fibremesh in strict accordance with manufacturer's printed instructions.

5. Screed Mix: Mix screed materials, admixtures and water in appropriate drum-type batch machine mixer or truck mixer according to manufacturer's written instructions.

6. Resinous Materials: Mix components and prepare materials for resinous floor treatment systems according to manufacturer's written instructions. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

### 9.3 INSTALLATION

#### 9.3.1 Workmanship

Add the following new paragraphs:

8. Apply screeds in strict accordance to with requirements of BS 8204-1 in construction types as the following:
   
   (a) Fully Bonded Construction: Stairs landings.
   (b) Partially Bonded Construction: Flat roof and levelling screeds under floor finishes.
   (c) Start screed application in presence of manufacturer's technical representative.

9. Bonding Agent: apply in strict accordance with manufacturer’s printed instructions.

10. Thickness of Levelling Screed: As required to attain finish floor levels indicated on
Drawings for different overlaying floor finishes.

11 Roof Screeds Thickness: 50 mm, minimum.

12 Place screed continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

13 Screed surface with a straightedge and strike off to correct elevations.

14 Slope surfaces uniformly where indicated or where necessary to drain surface water to floor drains in toilets, bathrooms, laundries and other similar wet areas.

15 Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

16 Finishing of Levelling Screeds: Consolidate surface with power-driven floats as soon as screed can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform and smooth texture.

17 Finishing of Roof Screed: Smooth float finish using hand float or skip float to give an even surface with ridges or steps.

18 Tolerances: Comply with BS 8204-1, if not covered in this clause.

19 Construction Joints: Construct joints true to line with faces perpendicular to surface plane of screed, at locations indicated or as approved by the Engineer.
   (a) Coat face of construction joint with epoxy adhesive at locations where screed is placed against hardened or partially hardened screed.

20 Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 3 mm wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before screed develops random contraction cracks.
   (a) Form joints in screed over contraction joints in base slabs, unless otherwise indicated.
   (b) Construct contraction joints for a depth equal to one-half of screed thickness, but not less than 13 mm deep.

21 Field Quality Testing: Engage an inspection and testing agency approved by the Engineer to perform field quality testing specified in this Article. All field quality testing shall be at the Contractor's expense.
   (a) Mix sample sets at point of placement, testing and inspecting agency shall take a set of 3 moulded-cylinder samples from the screed mix for the first 50 sq. m plus 1 set of samples for each subsequent 150 sq. m of screed, or fraction thereof, but not less than 6 samples for each day's placement. Samples shall be tested according to BS 4551-1 for compliance with compressive strength requirements.
Add the following new subclauses:

9.3.2 Screed Protection, Curing and Cleaning

1 Protect freshly placed screed from premature drying and excessive cold or hot temperatures.

2 Begin curing immediately after finishing screed. Cure by one or a combination of the following methods, according to screed manufacturer's written instructions:

3 Moisture Curing: Keep surfaces continuously moist for not less than seven days with water or absorptive cover, water saturated and kept continuously wet. Cover screed surfaces and edges with 300-mm lap over adjacent absorptive covers.

4 Joint Filling: For joints to be finished with sealant, prepare and clean perimeter joints according to sealant manufacturer's written instructions, once screed has fully cured. Remove dirt, debris, mortar from joints; leave contact faces of joint clean and dry. Overfill joint and tool flush with adjoining finish surface after hardening.

5 Protect screeds from damage and wear during the remainder of construction period. Use protective methods and materials approved by Engineer, including temporary covering.

6 Clean screeds not more than 4 days before dates scheduled for inspections intended to install final finishes.

9.3.3 Hardener Application

1 Preparation: Prepare and clean substrate according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral substrate for resinous flooring application.

2 Concrete and Cementations Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminates incompatible with resinous flooring. Comply with ASTM C 811 requirements, unless manufacturer's written instructions are more stringent. Cementitious surface shall be at least 4 weeks old at time of application.

3 Shot-blast surfaces with an apparatus that abrades the concrete or screed surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.

4 Repair damaged and deteriorated concrete or screed according to resinous flooring manufacturer's written recommendations.

5 Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations.

6 Coating: shall be applied to the prepared surface using airless spray, brush or lambswool roller. Ensure that the area is completely coated and that ponding of the material does not occur. Comply with manufacturer's printed instructions for
application pertaining, but not limited to, the following:

(a) Time elapse between successive coats
(b) Wet film thickness required to achieve the specified dry film thickness.

7 Erect epoxy floor hardener in two-coat application and finish to a low-sheen. Dry film thickness for each coat shall not be less than recommended by manufacture.

8 Cleaning and Protecting: Protect floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer. Clean floor treatment not more than 4 days before dates scheduled for inspections intended to establish date of Taking Over by Employer in each Project area. Use cleaning materials and procedures recommended in writing by treatment manufacturer.

Add the following new Clause:

9.4 MATERIALS

9.4.1 Screed Materials

1 Portland Cement: BS EN 197-1, ordinary type of grey colour.

2 Aggregate:
   (a) Sand: To BS EN 13139. Grading Limit: In accordance with BS 8204-1, Table B1.
   (b) Coarse aggregates for fine concrete levelling screeds: To BS EN 12620. Designation: 4/10

3 Admixtures: To BS EN 934-3, certified by manufacturer to contain no more than 0.1% water-soluble chloride ions by mass of cementitious material and compatible with other admixture and cementitious materials. Do not use admixtures containing calcium chloride. Use only liquid type admixtures.

4 Water for Mixing and curing: Potable.

5 Fibrous Reinforcement: 100% virgin polypropylene, fibrillated fibres containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement as crack controlling additive for cementitious materials. Fibrous reinforcement shall have the following properties:
   (a) Specific gravity: 0.91
   (b) Tensile strength: 345 - 758 N/mm2.

6 Self-Levelling Pre-Mixed Cement Screed: Pre-mixed blend of Portland cement, water, and aggregate offering high quality cement-based-self-leveling floor screed over concrete substrate, specially formulated to be low shrinkage to minimize the formation of surface cracking becomes a flowable and pumable self-leveling floor screed with addition of water, excellent workability properties and good
compaction. Comply with the following requirements:

(a) Compressive Strength at 28 Days: 24 MPa.
(b) Flexural Strength at 28 Days: 6 MPa.
(c) Linear Shrinkage at 28 Days: < 0.1%, maximum.

7 Absorptive Cover for Curing: Burlap cloth made from jute, weighing approximately 305 g/sq. m when dry.

8 Joint-Filler Strips: Asphalt-saturated cellulosic fibre, cork or self-expanding cork.

9 Acrylic-Bonding Agent: Non-redispersible, acrylic emulsion or styrene butadiene. Use of PVA-based bonding agents shall not be permitted.

10 Epoxy Adhesive: ASTM C 881, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

11 Flexible Joints: Are to be pre-fabricated, heavy-duty EPDM rubber section reinforced with aluminium or PVC angles and confirming to the applicable requirements of BS 5385: Part 3. Select depth of flexible joints so as top edges of side angles will be flush with adjoining finish material.

9.4.2 Resinous Floor

1 Use primer type as recommended by manufacturer for substrate and body coats indicated.

2 Epoxy Resin Floor Coating system shall be a two-component, solvent free, epoxy resin coating system supplied in pre-weighed packs ready for on-site mixing and use. The coating shall cure to a semi-gloss, impervious finish which is easily cleaned. Colour shall be selected from range of manufacturer’s standard colours by the Engineer. The used coating shall be of the following properties:

(a) Compressive Strength: 70 N/mm$^2$ after 28 days, according to EN 196-1.
(b) Flexural Strength: 35 N/mm$^2$ after 28 days, according to EN 196-1.
(c) Shore D Hardness: 76, according to DIN 53503.
(d) Abrasion Resistance: 70 mg (CS 10/1000/1000).
(e) Bond Strength: 1.5 N/mm$^2$ minimum according to ISO 4624.
(f) Hard wearing, durable and requires low maintenance costs
(g) Total Thickness: 1.0 mm.
(h) High resistance to industrial chemicals.
(i) Primer: As recommended by manufacture.
(j) Provide slip resistance by sprinkling aggregate on the wet applied first coat of resinous coating. Rate of sprinkling to be as recommended by manufacturer.
10. JOINT CAULKING AND SEALANT

10.1 GENERAL

10.1.2 Reference

Add the following new References:

- BS EN ISO 11600 Building construction. Jointing products. Classification and requirements for sealants

Add the following new sub-clauses:

10.1.7 Delivery, Storage and Handling

1. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, colour, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

2. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

10.1.8 Project Conditions

1. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

2. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

10.2 MOVEMENT JOINTS IN TILED FLOORS

10.2.1 Installation and Workmanship

Add the following at the end of paragraph no. 1:

“Where intermediate movement joints or flexible joints are used to divide floors into bays they will be erected with prefabricated joint sections as specified in alterations for relevant Specifications Sections.”

10.4 MATERIALS

10.4.1 Movement Joint Filler and Sealant

Add the following at the end of paragraph no. 1:

“and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.”
10.4.2 Products

*Add the following new paragraphs:*

9 Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

10 Colours of Exposed Joint Sealants: Shall be as selected by Engineer from manufacturer's full range for this characteristic.

11 Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

12 Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

13 Joint sealants used in wet areas, toilets and kitchens shall be with a fungicide to prevent mildew growth.

14 Sealants for joints that may be exposed to direct sun rays shall be UV-resistant.

15 Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

10.5 WORKMANSHIP

10.5.1 Execution

*Add the following new paragraphs:*

14 Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

(a) Remove excess sealants from surfaces adjacent to joint as specified.

(b) Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

(c) Provide concave joint configuration, unless otherwise indicated.

(d) Use masking tape to protect adjacent surfaces of recessed tooled joints.

15 Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

16 Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or
deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

17 Sealant Installation Standard: Comply with the following:

(a) BS 5212-2 for installing cold-applied joint sealant systems for concrete pavement.
(b) BS 8000-16 for installing joint sealants in buildings and workmanship requirements.
12. CARPETING

12.1 GENERAL REQUIREMENTS

12.1.3 Submittals

Delete clause no. 5 and replace with the following new paragraph.

5 Shop Drawings: Show the following:
   (a) Columns, doorways, enclose walls or partitions, built-in cabinets, and locations where cut-outs are required in carpet.
   (b) Carpet type, colour, and dye lot.
   (c) Seam locations, types, and methods.
   (d) Type of subfloor.
   (e) Type of installation.
   (f) Pattern type, repeat size, location, direction, and starting point.
   (g) Pile direction.
   (h) Type, colour, and location of inserts and borders.
   (i) Type, colour, and location of edge, transition, and other accessory strips.
   (j) Transition details to other flooring materials.

Add the following new sub-clauses:

12.1.4 Quality Assurance

1 Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

2 Comply with QSAS requirements.

3 Mockups: Before installing carpet, install mockups for each type of installation required to demonstrate aesthetic effects and qualities of materials and execution. Install mockups to comply with the following requirements, using materials indicated for the completed Work:
   (a) Install mockups in the location and of the size directed by Engineer.
   (b) Notify Engineer seven days in advance of dates and times when mockups will be installed.
   (c) Demonstrate the proposed range of aesthetic effects and workmanship.
   (d) Obtain Engineer's approval of mockups before starting work.
   (e) Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
(f) Remove mockups when directed.

(g) Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

4 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

12.1.5 Project Conditions

1 Do not install carpet until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

2 Do not install carpet over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet manufacturer.

3 Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

12.1.6 Warranty

1 Written warranty, signed by carpet manufacturer agreeing to replace carpet that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse. Failures include, but are not limited to, more than 10% loss of face fibre, edge ravelling, snags, runs, and delamination.

   (a) Warranty Period: 10 years from date of Substantial Completion.

2 Special Carpet Cushion Warranty: Written warranty, signed by carpet cushion manufacturer agreeing to replace carpet cushion that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse. Failure includes, but is not limited to, permanent indentation or compression.

   (a) Warranty Period: 10 years from date of Substantial Completion.

12.1.7 Extra Materials

1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   (a) Carpet: Full-width rolls equal to 5% of amount installed for each type indicated, but not less than 10 sq. m.
12.3 SHEET CARPETING (STANDARD ROLL CARPET)

12.3.2 Products

Delete its entirely content and replace with the following:

1 Provide carpet rolls to comply with the following requirements:

<table>
<thead>
<tr>
<th>Type</th>
<th>ISO 2424</th>
<th>Tufted 1/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Content</td>
<td>ISO 2424</td>
<td>100 % synthetic fiber nylon</td>
</tr>
<tr>
<td>Aspect</td>
<td>ISO 2424</td>
<td>Structured loop pile</td>
</tr>
<tr>
<td>Dye method</td>
<td>ISO 2424</td>
<td>Solution dyed</td>
</tr>
<tr>
<td>Dimension</td>
<td>ISO 2424</td>
<td>Custom</td>
</tr>
<tr>
<td>Total thickness</td>
<td>ISO 1765</td>
<td>6 mm</td>
</tr>
<tr>
<td>Effective pile thickness</td>
<td>ISO 1766</td>
<td>2.4 mm</td>
</tr>
<tr>
<td>Total mass</td>
<td>ISO 8543</td>
<td>4150 g/m²</td>
</tr>
<tr>
<td>Total pile mass</td>
<td>ISO 2424</td>
<td>650 g/m²</td>
</tr>
<tr>
<td>Effective pile mass</td>
<td>ISO 8543</td>
<td>345 g/m²</td>
</tr>
<tr>
<td>Pile density</td>
<td>ISO 8543</td>
<td>0.144 g/cm³</td>
</tr>
<tr>
<td>Horizontal resistance</td>
<td>ISO 10965</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance</td>
<td>ISO 8302</td>
<td>0.040 m².K/W</td>
</tr>
<tr>
<td>Flammability</td>
<td>EN 13501-1</td>
<td>Bfl - s1 (loose laid tested)</td>
</tr>
</tbody>
</table>

2 Accessories:

(a) Trowelable Levelling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by the following:

(i) Carpet manufacturer.

(b) Adhesives: Water-resistant, mildew-resistant, non-staining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and that is recommended by carpet cushion manufacturer.

(c) Metal Edge Strips: Extruded aluminium with mill finish of width shown, of height required to protect exposed edge of carpet, and of maximum lengths of manufacture standard to minimize running joints.

12.3.3 Installation of Carpet

Add the following new paragraphs:

2 Maintain uniformity of carpet direction and lay of pile. At doorways, centre seams under door in closed position. Bind or seal cut edges as recommended by carpet manufacturer.

3 Verify that concrete slabs are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet and cushion manufacture.
4 Use trowelable levelling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

5 Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

6 Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use non-permanent, non-staining marking device.
13 OTHER FLOOR COVERING

13.1 GENERAL

13.1.1 Scope

Amend clause no. 1 to be read as follows:

1 This Part specifies the requirements for sheet vinyl flooring.

Add the following new sub-clauses:

13.1.3 Submittals

1 Product Data: For each type of product indicated including product test reports.

2 Installer Experience: List of five projects (minimum) of a similar nature carried out successfully by the installer with the same product endorsed by the manufacturer's representative.

3 Samples for Initial Selection: For each type of floor covering indicated. Include similar Samples of installation accessories involving colour selection.

4 Samples for Verification: In manufacturer's standard size, but not less than 150-by-230-mm sections of each different colour and pattern of floor covering required. For heat-welding bead, submit manufacturer's standard-size samples, but not less than 230 mm long, of each colour required.

5 Heat-Welded Seam Samples: For each flooring product and welding bead colour and pattern combination required; with seam running lengthwise and in centre of 150-by-230-mm Sample applied to a rigid backing and prepared by Installer for this Project.

6 Maintenance Data: For floor coverings to include in maintenance manuals.

13.1.4 Quality Assurance

1 Provide mockups to verify selections made under sample Submittals and to demonstrate qualities of materials and execution and to set quality standard for fabrication and installation.

(a) Locations of mockups shall be as selected by Contractor and approved by Engineer.

(b) Extent of Mockups: full area of one building space not less than 10 sq. m of surface for each product indicated.

(c) Approved mockups may become part of the completed Work if undisturbed at time of substantial completion of sheet vinyl floor coverings work.

2 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among
13.1.5 Delivery, Storage and Handling

1  Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 10 deg C or more than 32 deg C. Store rolls upright.

13.1.6 Project Conditions

1  Maintain temperatures within range recommended by manufacturer, but not less than 21 deg C or more than 29 deg C, in spaces to receive floor tile during the following time periods:

   (a)  48 hours before installation.
   (b)  During installation.
   (c)  48 hours after installation.

2  After post-installation period, maintain temperatures within range recommended by manufacturer, but not less than 13 deg C or more than 35 deg C.

3  Close spaces to traffic during floor covering installation.

4  Close spaces to traffic for 48 hours after floor covering installation.

5  Install floor coverings after other finishing operations, including painting, have been completed.

13.2 FLEXIBLE FLOORING

13.2.1 Flexible Sheet and Tile Flooring

1  Sheet Vinyl Floor Covering for Dialysis hall / Clean utility / medication storages / solution stores

<table>
<thead>
<tr>
<th>Description (EN 649)</th>
<th>ISO 10581: Permanently Antistatic dissipative pressed homogeneous vinyl flooring. Type I. EN 685 - Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light fastness (EN ISO 105-B02) - Level</td>
<td>≥ 7</td>
</tr>
<tr>
<td>Reaction to fire</td>
<td>Bfl-s1</td>
</tr>
<tr>
<td>Electrical behaviour - vertical resistance (EN 1081) - Ohms</td>
<td>R1≤ 10 / R2≤ 10</td>
</tr>
<tr>
<td>Electrical resistance</td>
<td>R ≤ 10</td>
</tr>
<tr>
<td>Electrical insulation (VDE 100, Part 600) - Ohms</td>
<td>R ≤ 5x10</td>
</tr>
<tr>
<td>Electrical behaviour - body voltage (EN 1815) - kV</td>
<td>&lt; 2</td>
</tr>
</tbody>
</table>
### Sheet Vinyl Floor Covering for Corridors and other areas

<table>
<thead>
<tr>
<th>Property</th>
<th>Testing</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td></td>
<td>Homogenous antistatic Vinyl sheets flooring.</td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td>As indicated on Drawings</td>
</tr>
<tr>
<td>Total Thickness</td>
<td>EN 428</td>
<td>2.0 mm, according to EN 429</td>
</tr>
<tr>
<td>Total Weight</td>
<td></td>
<td>2.80 g/m2.</td>
</tr>
<tr>
<td>Dimensional stability</td>
<td></td>
<td>&lt; 0.40 %. According to ISO 23999-EN 434</td>
</tr>
<tr>
<td>Reaction to fire</td>
<td>S1 according to EN 13501-1</td>
<td></td>
</tr>
<tr>
<td>Abrasion</td>
<td></td>
<td>&lt; 2.0 mm3 according to EN 660-Part 2</td>
</tr>
<tr>
<td>Wear by Castor: Suitable;</td>
<td></td>
<td>in compliance with the DIN 54324.</td>
</tr>
<tr>
<td>Flame Spread</td>
<td>Class B1 in accordance with DIN 4102 as well as BS 476: Part 7.</td>
<td></td>
</tr>
<tr>
<td>Chemical Resistance</td>
<td>Resistant; in compliance with EN 423.</td>
<td></td>
</tr>
<tr>
<td>Light Fastness</td>
<td>&gt; Level 6; in compliance with the EN ISO 105-B02</td>
<td></td>
</tr>
<tr>
<td>Electrical Resistance</td>
<td>1011 Ohm in compliance with ASTM D 257.</td>
<td></td>
</tr>
<tr>
<td>Design Pattern</td>
<td>as shown on drawings and approved by the Engineer.</td>
<td></td>
</tr>
</tbody>
</table>

### Sheet Vinyl Floor Covering for kids area

<table>
<thead>
<tr>
<th>Property</th>
<th>Testing</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification</td>
<td>EN 651</td>
<td>34</td>
</tr>
<tr>
<td>CE Marked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Thickness</td>
<td>EN 428</td>
<td>3 mm</td>
</tr>
<tr>
<td>Wear Layer Thickness</td>
<td>EN 429</td>
<td>0.65 mm</td>
</tr>
<tr>
<td>Abrasion Group</td>
<td>EN 660-1</td>
<td>Group T: ≤ 2.0 mm</td>
</tr>
<tr>
<td>Dimensional stability</td>
<td>EN 434</td>
<td>&lt; 0.10%</td>
</tr>
<tr>
<td>Residual Indentation</td>
<td>EN 433</td>
<td>≤ 0.20 mm</td>
</tr>
<tr>
<td>Castor Wheel test</td>
<td>EN 425</td>
<td>No damage</td>
</tr>
<tr>
<td>Impact sound</td>
<td>EN ISO 140-8</td>
<td>L_w 19 dB</td>
</tr>
<tr>
<td>Reduction</td>
<td>EN ISO 717-2</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Slip Resistance</td>
<td>DIN 51130</td>
<td>R9</td>
</tr>
<tr>
<td>Electrostatic properties</td>
<td>EN 1815</td>
<td>&lt; 2 kV on concrete</td>
</tr>
<tr>
<td>Chemical Resistance</td>
<td>EN 423</td>
<td>High resistance</td>
</tr>
<tr>
<td>Light fastness</td>
<td>EN ISO 105-B02</td>
<td>≥ 6</td>
</tr>
<tr>
<td>Anti fungi treatment Resistance to microbes and bacteria</td>
<td>Does not contribute to infection spreading</td>
<td></td>
</tr>
</tbody>
</table>

Add the following new sub-clause:

4 Accessories

1 Adhesive Type: Water-resistant type recommended by manufacturer to suit sheet vinyl floor covering and substrate conditions indicated, comply with requirements of Section 7.

2 Trowelable Levelling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic cement based formulation provided or approved by floor covering manufacturer for applications indicated.

3 Heat-Welding Bead: Solid-strand product of floor covering manufacturer. Colour shall be as selected by Engineer from manufacturer's full range to match with floor covering.

4 Integral-Flash-Cove-Base Accessories:
   (a) Cove Strip: 25-mm radius provided or approved by floor covering manufacturer.
   (b) Cap Strip: Square metal, vinyl cap provided or approved by floor covering manufacturer.
   (c) Corners: Metal inside and outside corners and end stops provided or approved by floor covering manufacturer.

13.2.2 Laying Flexible Sheets and Tile Flooring

Add the following sentence at the end of Paragraph number 1:

Comply also with printed instructions and recommendations of the manufactures.

Amend Paragraph number 4 to be as follows:

4 Apply levelling and patching to all floors to be finished with vinyl flooring according to manufacturer's printed instructions.
Add the following new paragraphs:

9 Examine substrates for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.

10 Prepare substrates according to manufacturer’s written recommendations to ensure adhesion of floor coverings. Prepare cementitious substrates according to BS 8203. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

11 Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

12 Perform moisture control test to BS 8203 or other tests recommended by manufacturer. Proceed with installation only after substrates have maximum moisture-vapour-emission rate of 1.36 kg of water/92.9 sq. m in 24 hours.

13 Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

15 Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

16 Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

17 Lay out sheet vinyl floor coverings as follows:

(a) Maintain uniformity of floor covering direction.

(b) Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 152 mm away from parallel joints in floor covering substrates.

(c) Match edges of floor coverings for colour shading at seams.

(d) Avoid cross seams.

(e) Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosing.

(f) Extend floor coverings into toe spaces, door reveals, closets, and similar openings.

(g) Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates.

(h) Use chalk or other non-permanent marking device.

(i) Install floor coverings on covers for telephone and electrical ducts and
similar items in installation areas. Maintain overall continuity of colour and pattern with pieces of floor coverings installed on covers. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.

(j) Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

(k) Heat-Welded Seams: Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.

Add the following new sub-clauses:

13.2.3 Cleaning and Protection

1 Perform the operations specified in following paragraphs immediately after completing floor covering installation:

   (a) Remove adhesive and other blemishes from floor covering surfaces.

   (b) Sweep and vacuum floor coverings thoroughly.

   (c) Damp-mop floor coverings to remove marks and soil.

13.4 ROLL-UP MATS

13.4.1 Roll-up, Aluminum-Rail Hinged Mats

   Extruded-aluminum tread rails sitting on continuous vinyl cushions.

1 Tread Inserts: Plain serrated aluminum treads.

2 Colors, Textures, and Patterns of Inserts: As selected by Engineer from manufacturer's full range.

3 Rail Color: Mill-finish.

4 Hinges: Aluminum.

5 Mat Size: As indicated.

13.4.2 Recessed Frames

1 Extruded Aluminum: ASTM B 221M, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.

2 Color: As selected by Engineer from manufacturer's full range.

13.4.3 Concrete Fill And Grout Materials

1 Provide concrete grout and fill equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.
13.4.4 Fabrication

1 Floor Mats: Shop fabricate units to greatest extent possible in sizes as indicated. If not otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

2 Surface-Mounted Frames: As indicated for permanent surface-mounted installation, complete with corner connectors, splice plates or connecting pins, and postinstalled expansion anchors.

3 Recessed Metal Mat Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.

   (a) Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

4 Coat surfaces of aluminum frames that will contact cementitious material with manufacturer's standard protective coating.

13.4.5 Aluminum Finishes

1 Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2 Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

3 Mill Finish: AA-M10 (Mechanical Finish: as fabricated; no other applied finish unless buffing is required to remove scratches, welding, or grinding produced in fabrication process).
14 CEILINGS

14.1 GENERAL DESCRIPTION

14.1.1 Scope

*Delete in its entirety paragraph no. 1 and replace with the following:*

1 This part specifies requirements for suspended false ceilings including the following types and constructions:

(a) Gypsum board suspended ceilings.
(b) Moisture resistant gypsum board suspended ceiling.
(c) Aluminium linear metal strips.
(d) Mineral fibre acoustical tiles.

Extent of each type of suspended ceilings are indicated on Drawings.

*Add the following sections in paragraph 2 as related sections:*

- Section 21 Electrical Works
- Section 22 Air Conditioning, Refrigeration and ventilation

*Add the following new paragraph:*

3 Definitions

(a) AC: Articulation Class.
(b) CAC: Ceiling Attenuation Class.
(c) LR: Light Reflectance coefficient.
(d) NRC: Noise Reduction Coefficient.

14.1.2 References

*Delete paragraph no. 1 and replace with the following:*

1 The following standards are referred to in this Section:

**British Standard Institute (BSI) - UK**

- BS EN 520 Gypsum plasterboards. Definitions, requirements and test methods.
- BS 6496 Specification for powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and performed sections coated with.
BS 8212  Code of practice for dry lining and partitioning using gypsum plasterboard
BS 8290-1  Suspended ceilings. Code of practice for design
BS 8290-2  Suspended ceilings. Specification for performance of components and assemblies
BS 8290-3  Suspended ceilings. Code of practice for installation and maintenance
BS EN 485  Aluminium and aluminium alloys.
BS EN 10143  Continuously hot-dip metal coated steel sheet and strip  Tolerances on dimensions and shape
BS EN 10218  Steel wire and wire products
BS EN 10244  Steel wire and wire products
BS EN 10327  Continuously hot-dip coated strip and sheet of low carbon steels for cold forming. Technical delivery conditions
BS EN 13964  Suspended ceilings. Requirements and test methods

Deutsches Institute fur Normung (DIN) - Germany

DIN 18168-2  Lightweight ceiling linings and suspended ceilings; verification of the load bearing capacity of metal substructures and hangers
DIN 18182-2  Accessories for use with gypsum plasterboards; dry wall screw
DIN 4102-1  Fire behaviour of building materials and building components- Part 1: Building materials; concepts, requirements and tests.

14.1.3 General Requirements

**Add the following new paragraphs:**

5  Deliver materials for all types of suspended in manufacturers’ original unopened packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

6  Store materials indoors, under cover and on raised platforms and keep them dry and protected against damage from weather, sun, surface contamination, rust, soil, corrosion, construction traffic, and other causes.

7  Comply with manufacturers’ recommendations for storing of materials. Do not stack material in a manner that may cause damage or distortion under its own weight. Stack gypsum boards flat to prevent sagging.

8  Source Limitations for Suspended Ceilings: Obtain each suspended ceiling system including suspension system and ceiling membrane boards from one source with resources to provide products of consistent quality in appearance
and physical properties without delaying the Work.

9 Coordination: Coordinate layout and installation of suspended ceilings with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system and partition assemblies.

10 Access Panels: Provide access panels at locations selected by the Engineer and indicated on approved reflected ceiling plans.

14.1.4 Submittals

Delete in its entirety paragraphs and replace with the following new paragraphs:

1 Product Data: For each type of product specified.

2 Manufacturers' product data for sealants, including printed statement of VOC content and material safety data sheets.

3 Performance Data: For installed products indicated to comply with design loads and other criteria, include structural analysis and other analytical data signed and sealed by the qualified professional engineer responsible for their preparation.

4 Coordination Drawings: Reflected ceiling plans drawn to minimum drawing scale: 1:50 and coordinating penetrations and ceiling-mounted items. Show the following:

   (a) Joint pattern.
   (b) Ceiling suspension system members.
   (c) Method of attaching suspension system hangers to building structure.
   (d) Initial direct-access openings.
   (e) Ceiling-mounted items including light fixtures; air outlets and inlets; speakers; sprinklers; and special mouldings at walls, column penetrations, and other junctures of ceilings with adjoining construction.

5 Samples for Initial Selection: Manufacturer’s colour charts consisting of actual sections of boards and mouldings showing the full range of colours, textures, and patterns available for each type of ceiling assembly indicated.

6 Samples for Verification: Full-size units of each type of ceiling assembly specified; in sets for each colour, texture, and pattern specified, showing the full range of variations expected in these characteristics.

   (a) 600 mm- square units.
   (b) 300 mm- long samples of each exposed moulding.

7 Product Test Reports: Indicate compliance of suspended ceilings and components with requirements based on comprehensive testing of current products.
Add the following new sub-clauses:

14.1.5 Quality Assurance

1 Manufacture Qualifications: Manufacture with not less than 10 years' experience with successful production of products and systems similar to scope of this Project, with a record of successful in-service performance and completion of projects for a period of not less than 10 years and with sufficient production capability, facility, and personal to produce required Work.

2 Installer Qualifications: Engage an experienced installer who has completed suspended ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

3 Source Limitations: Obtain each set of tiles and suspension systems from one source with resources to provide products of consistent quality in appearance, physical properties, and performance.

4 Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to the gypsum board manufacturer.

5 Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions.

6 Mockups: Build mockups of each ceiling type to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   (a) Install mockups of at least 9 sq. m in surface area to demonstrate aesthetic effects and qualities of materials and execution.
   (b) Simulate finished lighting conditions for review of mockups.
   (c) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

7 Document Conflict and Precedence:
   (a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.
   (b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

14.1.6 Project Conditions

1 Environmental Limitations: Do not install suspended ceilings until spaces are enclosed and weather tight, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
14.1.7 Extra Materials

1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

2 Suspended Ceiling Components: Quantity of each product equal to 5% of quantity installed.

14.3 FIXED TYPE SUSPENDED CEILINGS

14.3.2 Materials

Amend paragraph 1 to read as follows:

1 Gypsum wallboard shall be 12.50 mm thick minimum to BS EN 520.

Replace paragraphs no. 2 and 4 with the following new paragraphs:

2 Gypsum Board: Complying with the following:
   (a) Provide gypsum board in widths of 1200 mm.
   (b) Composition: The mix for manufacture of gypsum boards shall incorporate reinforcing non-combustible glass fibers.
   (c) Sag-Resistant Type A.
   (d) Moisture resistant gypsum board: Type H grade H1, manufactured to reduce water absorption rate.
   (e) Weight: 10 kg/m² minimum.

4 Metal Suspension Systems

   (a) Provide manufacturer’s standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in BS EN 13964.
   (b) Finishes and Colours: Provide manufacturer’s standard factory-applied finish for type of system indicated.
      (i) High-Humidity Finish: Comply with BS EN 13964 requirements where high-humidity finishes are indicated.

5 Support Systems and Fixings:

   (a) Mild steel suspension systems shall be hot dip galvanized to BS EN ISO 1461 with cold rolled channels and sections to BS EN 10162 and BS 7364.
   (b) Indirect-Hung Suspension System: Main and cross runners roll formed from cold-rolled steel sheet.
(i) Structural Classification: Heavy-duty system.
(ii) End Condition of Cross Runners: Override (stepped) type.
(iii) Face Design: Flat, flush.
(iv) Cap Material: Aluminium cold-rolled sheet.
(v) Cap Finish: Painted white or painted in colour as selected from manufacturer’s full range.
(vi) Furnish all necessary components for fixed suspended gypsum board ceilings as indicated in technical data sheets of approved manufacturer for selected system and comply with requirements indicated here after

6 Clips: Steel wire, minimum Z 120 zinc coating, soft temper.

7 Hanger Attachments to Concrete: Shall be post installed anchors in concrete, expansion type fabricated from carbon steel and of zinc plated finish with minimum zinc coating thickness of 0.005 mm (5 microns), complete with holes or loops for attaching hangers and of capability to sustain, without failure, a load equal to five times that imposed by ceiling construction.

(a) Corrosion resistance anchors, inserts, fasteners and other such devices shall comply with BS 4183, BS EN ISO 1580, BS EN ISO 7045 and BS EN ISO 3506 or as equal in American Standards.

8 Wire Hangers: to BS EN 10218 AND 10244 zinc coating, soft temper.

9 Flat Hangers: Steel sheet, BS EN 10142, Z 180 hot-dip galvanised zinc coating, furnish complete with cleats and anchors as specified.

10 Carrying Channels: Cold-rolled, steel sheet with a base metal to BS EN 10142, Z180 hot-dip galvanised zinc coating. Depth shall be as recommended by manufacturer.

11 Furring Channels (Furring Members): Cold rolled channels, steel sheet to BS EN 10142, Z 180, hot-dip galvanised zinc coating.

12 Cross Connectors: Manufacturer’s standard fabricated from corrosion-resistant material.

13 Seismic Struts: Manufacturer’s standard compression struts designed to accommodate seismic forces.

14 Seismic Clips: Manufacturer’s standard seismic clips designed and spaced to secure tiles in-place.

15 Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 610 mm o.c. on all cross tees.

16 Impact Clips: Where indicated, provide manufacturer’s standard impact-clip system designed to absorb impact forces against tiles.

17 Joint Treatment Materials: Shall comply with requirements of BS 8212 and
manufacturer’s recommendations, as follows.

(a) Jointing Compounds: for gypsum boards shall be proprietary drying-type factory-packaged vinyl-based factory-mixed products complying with specified requirements for formulation and intended use.

(b) Joint Tapes for Gypsum Board: Shall be pressure sensitive or staple attached proprietary reinforcing tapes, compatible with and as recommended for particular purpose and application by jointing compound manufacturer.

(c) Joint Compound for Exterior Applications: As recommended by manufacture.

18 Fixings and suspension system shall be fully concealed including all hangers, fixings, main runners, cross members, primary channels, perimeter trims, splines, noggins, clips, bracing, bridging, etc., which are necessary to complete the installation and achieve the performance specified.

19 Metal Edge Mouldings and Trim

(a) Extruded-Aluminium Edge Mouldings and Trim: Where indicated, provide manufacturer’s extruded-aluminium edge mouldings and trim of profile indicated or referenced by manufacturer’s designations, including splice plates, corner pieces, and attachment and other clips, complying with the following requirements:

(i) Aluminium Alloy: Alloy and temper recommended by aluminium producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminium extrusions complying with requirements of BS EN 485, BS EN 515, BS EN 573, BS EN 755, BS EN 12020 and temper 6063-T5.

(ii) Finish match finish of grid system.

14.3.3 Installation

Add the following new paragraphs:

3 Comply with BS 8212 and BS EN 13964, unless otherwise more stringent requirements are specified hereafter.

4 Install ceiling board across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent boards not less than one framing member.

(a) Install gypsum boards with face side out. Butt boards together for a light contact at edges and ends with not more than 1.5 mm of open space between boards. Do not force into place.

(b) Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back blocking is provided behind end joints. Do not place tapered edges against cut edges or ends.
Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

(c) Attach gypsum boards to framing provided at openings and cut-outs.

(d) Form control and expansion joints with space between edges of adjoining gypsum boards.

(e) Space fasteners in gypsum boards according to referenced gypsum board application and finishing standard and manufacturer’s written recommendations.

(f) Install control joints according to requirements of referenced installation standards and in specific locations approved by Engineer for visual effect.

(g) Space screws a maximum of 200 mm o.c. for ceilings.

5 Suspend ceiling hangers from building’s structural members and as follows:

(a) Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

(b) Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

(c) Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

(d) Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

(e) Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

(f) Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

(g) Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or
adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

(h) Attach hangers to structural members.

(i) Space hangers not more than 1200 mm o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 200 mm from ends of each member.

(j) Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

(k) Screw attach mouldings to substrate at intervals not more than 400 mm o.c. and not more than 75 mm from ends, levelling with ceiling suspension system to a tolerance of 3.2 mm in 3.66 m. Mitre corners accurately and connect securely.

(l) Do not use exposed fasteners, including pop rivets, on mouldings and trim.

(i) Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

(m) Install tiles with undamaged edges and fit accurately into suspension system runners and edge mouldings. Scribe and cut tiles at borders and penetrations to provide a neat, precise fit.

(i) Arrange directionally patterned tiles as follows:
   1) As indicated on reflected ceiling plans.

(ii) For square-edged tiles, install tiles with edges fully hidden from view by flanges of suspension system runners and mouldings.

(iii) For reveal-edged tiles on suspension system runners, install tiles with bottom of reveal in firm contact with top surface of runner flanges.

(iv) Paint cut edges of tile remaining exposed after installation; match colour of exposed tile surfaces using coating recommended in writing for this purpose by tile manufacturer.

(v) Install hold-down clips for all ceilings; space as recommended by tile manufacturer's written instructions.

(vi) Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

6 Board Application Methods: Apply gypsum boards for ceilings in single-layer application. Apply gypsum boards before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated. Apply gypsum boards to supports with steel drill screws.

7 Coffers: Shall be constructed to details indicated on Drawings and shop drawings. Provide furring studs and runners at maximum intervals of 600 mm
constructed from galvanised steel sheets as specified in sub-clause 14.3.2 “Materials” in this Section.

8 Installing Trim Accessories: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for boards. Otherwise, attach trim according to manufacturer's written instructions.

9 Finishing Gypsum Board Ceilings: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces. Prefill open joints, rounded or bevelled edges, and damaged surface areas. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

(a) Gypsum Board Finish: Taped seamless finish as follows:
(b) Lightly sand cut edges of boards to remove paper burrs; apply PVAC sealer to exposed cut edges of boards to which tape is to be applied.
(c) Fill all joints and gaps and cover with continuous lengths of tape, fully bedded; when set, cover with joint finish, feathered out to give a flush, smooth, seamless surface; apply two coats of joint finish at external angles.
(d) Spot nail and screw depressions with joint filler and when set apply a continuous overall coat of joint finish, feathered off to give a flush, smooth surface.
(e) Fill minor indents and, after joint, angle and spotting treatments have dried, apply surface finish slurry to give a continuous, consistent texture to surface of boards.

10 Recessed Lighting Enclosure: Shall be constructed from 16.00 mm thick gypsum boards fixed to galvanized steel furring channels not less than 0.70 mm thick with galvanized steel plasterboard screws. Provide alloy 304 S16 stainless steel griller of satin finish loosely laid onto T-section supports of material and finish matching that of the adjoining suspended ceiling. Inner surfaces of plasterboards are to receive smooth acrylic paint finish of white colour.

Add the following new sub-clause:

14.3.4 Acoustical Tile Ceilings

1 General

(a) Provide acoustical tiles with face and back surfaces coated with antibacterial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mould and mildew and showing no mould or mildew growth when tested according to ASTM D 3273 for 30 years.
(b) Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
(i) Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:

1) Smoke-Developed Index: 450 or less.

(c) Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance, unless otherwise indicated.

(i) Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 400 mm away from test surface per ASTM E 795.

2 Cast or Moulded, Mineral-Base Acoustical Panels

(a) Where indicated, provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:

(i) Type and Form: Type III, mineral base with painted finish; nodular or Form 4, cast or molded.

(ii) Acoustic Requirements:

1) Noise Reduction Coefficient (NRC): 0.875 according to ASTM C 423; Classified with UL label.

2) Ceiling Attenuation Class (CAC): 28 according to ASTM C 1414; Classified with UL label.

(iii) Edge Detail: Square or Reveal sized to fit flange of exposed suspension system members.

(iv) Size: As indicated on Drawings.
Add the following new Part number 15 “Through Penetration Firestop Systems”

15. THROUGH PENETRATION FIRESTOP SYSTEMS

15.1 GENERAL

15.1.1 Scope

1 This Part includes through-penetration firestop systems for penetrations through
fire-resistance-rated constructions, including both empty openings and openings
containing penetrating items.

15.1.2 Performance Requirements

1 For the following constructions, provide through-penetration firestop systems that
are produced and installed to resist spread of fire according to requirements
indicated, resist passage of smoke and other gases, and maintain original fire-
resistance rating of assembly penetrated.

(a) Fire-resistance-rated non-load-bearing walls, including partitions, with fire-
protection-rated openings.

(b) Fire-resistance-rated floor assemblies.

(c) Fire-resistance-rated roof assemblies.

2 F-Rated Systems: Provide through-penetration firestop systems with F-ratings
indicated, as determined, per ASTM E 814, but not less than that equalling or
exceeding fire-resistance rating of constructions penetrated.

(a) Minimum fire rating of fire-rated system shall be as indicated on Fire Design
Drawing for the assembly that will be penetrated or opened.

3 T-Rated Systems: For the following conditions, provide through-penetration
firestop systems with T-ratings indicated, as well as F-ratings, as determined, per
ASTM E 814, where systems protect penetrating items exposed to potential
contact with adjacent materials in occupiable floor areas:

(a) Penetrations located outside fire-resistive shaft enclosures.

(b) Penetrations located in construction containing fire-protection-rated
openings.

(c) Penetrating items larger than 100 mm diameter nominal pipe or 100 sq. cm
in overall cross-sectional area.

4 For through-penetration firestop systems exposed to view, traffic, moisture, and
physical damage, provide products that after curing do not deteriorate when
exposed to these conditions both during and after construction.

(a) For piping penetrations for plumbing and wet-pipe sprinkler systems,
provide moisture-resistant through-penetration firestop systems.

(b) For floor penetrations with annular spaces exceeding 100 mm in width and
exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.

(c) For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

5 For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined, per ASTM E 84.

6 Provide through-penetration firestop systems complying with specified US standards or any approved equivalent European standards such as Euronorm or ISO.

15.1.3 Submittals

1 Product Data: For each type of through-penetration firestop system product indicated.

2 Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

3 Installer Certificates: Signed by product manufacturer certifying that the Installer is approved, authorized, or licensed by manufacturer to install his products.

4 Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

15.1.4 Quality Assurance

1 Installer Qualifications: An experienced installer who is qualified by having the necessary experience, staff, and training to install manufacturer's products per specified requirements. The installer should have completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance. Firestopping work shall be executed by one specialized subcontractor

2 Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

3 Information on Drawings referring to specific design designations of through-penetration firestop systems is intended to establish requirements for performance based on conditions that are expected to exist during installation. Any changes in conditions and designated systems require the Engineer's prior approval. Submit documentation showing that the performance of proposed substitutions equals or exceeds that of the systems they would replace and are acceptable to the Engineer.

4 Document Conflict and Precedence:
(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

15.2 MATERIALS

15.2.1 Firestopping

1 Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

2 Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

(a) Permanent forming/damming/backing materials, including the following:
   (i) Slag-/rock-wool-fibre insulation.
   (ii) Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   (iii) Fire-rated form board.
   (iv) Fillers for sealants.
   (v) Ceramic fibre.

(b) Temporary forming materials.

(c) Substrate primers.

(d) Collars.

(e) Steel sleeves.

15.2.2 Fill Materials

1 Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

2 Latex Sealants: Intumescent single-component latex formulations that after cure do not re-emulsify during exposure to moisture. Use for sealing nominal openings with penetrations of non-combustible items including; cast and steel pipe, copper pipe, conduit, electrical metallic tubing (EMT).

3 Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-
curing elastomeric sealants of grade indicated below:

(a) Use pourable (self-levelling) formulation for openings in floors and other horizontal surfaces.

(b) Use nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.

4 Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

5 Intumescent Composite Sheets: Rigid panels consisting of aluminium-foil-faced elastomeric sheet bonded to galvanized steel sheet. Use for large size - complex penetrations which accommodate individual or combinations of cable trays, multiple steel or copper pipes, electrical conduits, busways, or electrical/data/telecommunications cables.

6 Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibres, or silicone compounds.

7 Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminium foil on one side.

8 Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar. Use for large size - complex penetrations which accommodate individual or combinations of cable trays, multiple steel or copper pipes, electrical conduits, busways, or electrical/data/telecommunications cables.

9 Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives. Use for large size - complex penetrations which accommodate individual or combinations of cable trays, multiple steel or copper pipes, electrical conduits, busways, or electrical/data/telecommunications cables.

10 Acceptable product for sealing openings in areas requiring hazardous location protection, or in those that require an environmental seal against water or dust, or for clean room applications, or for those areas where cables - electrical/data telecommunications - require strain relief security against cable pullout. Use for sealing multiple cables passing through a single opening.

11 Ceramic-Fibre and Mastic Coating: Ceramic fibres in bulk form formulated for use with mastic coating, and ceramic fibre manufacturer’s mastic coating.

12 Ceramic-Fibre Sealant: Single-component formulation of ceramic fibres and inorganic binders.

13 Job-Mixed Vinyl Compound: Prepackaged vinyl-based powder product for mixing with water at Project site to produce a paintable compound, passing ASTM E 136, with flame-spread and smoke-developed ratings of zero, per ASTM E 84.
14 For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

15.3 APPLICATION

15.3.1 Examination

1 Examine substrates and conditions, with the Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

2 Proceed with installation only after unsatisfactory conditions have been corrected.

15.3.2 Preparation

1 Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:

   (a) Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.

   (b) Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.

   (c) Remove laitance and form-release agents from concrete.

2 Priming prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3 Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

15.3.3 Through-Penetration Firestop System Installation

1 Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

2 Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position
needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

(a) After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

3 Install fill materials for firestop systems by proven techniques to produce the following results:

(a) Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

(b) Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

(c) For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

4 Identification: Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 150 mm of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. Include the following information on labels:

(a) The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."

(b) Contractor's name, address, and phone number.

(c) Through-penetration firestop system designation of applicable testing and inspecting agency.

(d) Date of installation.

(e) Through-penetration firestop system manufacturer's name.

(f) Installer's name.

15.3.4 Field Quality Control

1 Engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

(a) Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

2 Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

3 Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
15.3.5 Cleaning and Protection

1. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

2. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.
Add the following new Part number 16 “Traffic Coating”

16. TRAFFIC COATING

16.1 GENERAL

16.1.1 Scope

1 This Section includes traffic coatings for pedestrian and vehicular applications.

2 Related Sections are as follows:

   Section 5 Concrete

   Section 24 Part 10 Joints, Caulking, and Sealants

16.1.2 References

1 The following standards are referred to in this Part:

   AASHTO M 248 Specification for Ready-Mixed White and Yellow Traffic Paints

   ASTM C 920 Specification for Elastomeric Joint Sealants

   ASTM C 957 Specification for High-Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with Integral Wearing Surface

   ASTM C 1127 Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with an Integral Wearing Surface

   ASTM C 1193 Guide for Use of Joint Sealants

   ASTM D 4258 Practice for Surface Cleaning Concrete for Coating

16.1.3 Submittals

1 Product Data: For each product indicated.

2 Shop Drawings: Show extent of each traffic coating. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions. Include layout of traffic striping and markings.

3 Samples: For each type of traffic coating required, prepared on rigid backing. Provide stepped samples on backing large enough to illustrate build-up of traffic coatings.

4 Material certificates and test reports prepared by an independent testing agency approved by Engineer.

5 Maintenance Data.
16.1.4 Quality Assurance

1 Installer (Applicator) Qualifications: An experienced applicator who is certified by manufacturer.

2 Use traffic coatings of a single manufacturer.

3 Apply mockups to demonstrate qualities of materials and workmanship.
   (a) Apply mockup as directed by Engineer.
   (b) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

4 Document Conflict and Precedence:
   (a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.
   (b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer

16.1.5 Delivery, Storage, and Handling

1 Comply with printed instructions of manufacturers.

2 Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels showing all information:

3 Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

16.1.6 Project Conditions

1 Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 5 deg. C when relative humidity exceeds 85 %, or when temperatures are less than 3 deg. C above dew point.

16.1.7 Warranty

1 Provide written warranty, co-signed by traffic coating manufacturer and installer agreeing to repair or replace traffic coatings that do not comply with requirements or that deteriorate during the specified warranty period. Warranty does not include deterioration or failure of traffic coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new substrate cracks exceeding 1.6 mm in width, fire, vandalism, or abuse by maintenance equipment, and truck traffic.
   (a) Deterioration of traffic coatings includes, but is not limited to, the following:
   (b) Adhesive or cohesive failures.
(c) Abrasion or tearing failures.
(d) Intrusion of water, oils, gasoline, grease, salt, or acids into substrate.
(e) Extraction of aggregate

2 Warranty Period: Five years from date of Substantial Completion.

16.2 MATERIALS

16.2.1 Traffic Coating

1 Traffic coatings are to be proprietary, factory formulated, high-solids, cold liquid-applied, elastomeric coatings that produce a tough wearing surface for vehicular or pedestrian traffic. The coatings shall form a protective, waterproof barrier capable of bridging minor cracks and resisting various chemicals. They shall be superior wear and abrasion resistant, shock and impact resistance and exhibit slip-and-skid resistance and low-temperature flexibility, have high substrate and intercoat bond strength, and withstand vehicular loadings including highly repeated point loadings.

(a) Where portions of applied traffic coatings may be subject to ultraviolet rays, use coating type that is certified by manufacturer as UV-resistant.
(b) Abrasion Resistance: Taber Abrader, 40 mg loss per 1000 cycles, maximum.
(c) Tear Resistance: 192 N minimum according to MOAT 27 Method 5.4.1
(d) Bond Strength Greater than cohesive strength of 25 N/mm² concrete > 1.5 N/mm².
(e) Tensile /Elongation (N/mm² / %) after 28 day: 7.17/30.5 according to BS 2782 Part 3 Method 320 A.
(f) Fire Resistance BS 476: Part 3: Designated EXT.FF.AA
(g) Water Permeability Nil – Karsten test (Impermeable)
(h) Slip Resistance: TRRL Pendulum Slip Test:
   (i) Dry: 92
   (ii) Wet: 46
(i) Chemical Resistance: Extreme resistant to petrol, diesel, antifreeze, hydraulic fluid, chlorides and battery acids.
(j) Colours of traffic coatings: Light grey and shall be selected by the Engineer from manufacturer's full range of colours
(k) Primer: Manufacturer's standard factory-formulated primer recommended for substrate and conditions indicated.
   (i) Material: Epoxy.
(l) Preparatory and Base Coats: Single- or multicomponent aromatic liquid urethane elastomer.
(m) Intermediate Coat: Single- or multicomponent aliphatic liquid urethane
elastomer.

(n) Top Coat: Single- or multicomponent aliphatic liquid urethane elastomer.

(o) Aggregates: Uniformly graded washed silica sand.

(p) Pedestrian Traffic Coating Grade: Use medium duty for pedestrian traffic.

(q) Vehicular Traffic Coating Grade: Use heavy-duty grade at ramps and turning areas; use medium-duty grade at driving aisles and parking bays, all as recommended by manufacturer.

(r) For external area: Solar reflectance value shall not be less than 0.50.

2 Component Coat Thicknesses: As recommended by manufacturer for substrate and service conditions indicated, but not less than 2.0 mm dry film

3 Aggregate: Uniformly graded silica sand of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.

(a) Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated.

16.2.2 Miscellaneous Materials

1 Joint Sealants: Multicomponent urethane sealant recommended in writing by manufacturer for substrate and joint conditions indicated and for compatibility with traffic coatings; complying with ASTM C 920, Type M, Class 25, Grade NS for sloping and vertical applications or Grade P for deck applications, and Use T where subject to traffic or Use NT elsewhere.

2 Reinforcing Strip: Manufacturer's recommended fibreglass mesh.

3 Traffic Marker: Use same topcoat material with a different colour as follows:

(a) Colour: White or directed by the Engineer.

4 Pre-cast Concrete Wheel Stopper: Pre-cast concrete wheel stopper, minimum 30 MPa to provide low impact resistance parking slow moving cars and light commercial vehicles.

(a) Suitable for outdoor and indoor car park areas.

(b) Comply with details and dimensions indicated on Drawings.

(c) Comply with requirements specified in QCS Part 5 “Concrete”.

16.3 EXECUTION

16.3.1 Application

1 Comply with ASTM C 1127 and manufacturer's written recommendations.

2 Verify compatibility with and suitability of substrates and that substrates are visibly dry and free of moisture.
(a) Application of coating indicates acceptance of surfaces and conditions.

3 Begin coating application only after minimum concrete curing and drying period recommended by traffic coating manufacturer has passed and after surfaces are dry.

4 Clean and prepare substrates to produce clean, dust-free, dry substrate for traffic coating application.

5 Mask adjoining surfaces not receiving traffic coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.

6 Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.
   (a) Provide sealant cants at penetrations and at reinforced and non-reinforced deck-to-wall butt joints.
   (b) Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
   (c) Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates.

7 Prepare, treat, rout, and fill joints and cracks substrates. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

8 Start traffic coating application in presence of manufacturer's technical representative.
   (a) Verify that wet film thickness of each component coat complies with requirements every 9 sq. m.
   (b) Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated and omit aggregate on vertical surfaces.
   (c) Prevent contamination and damage during application and curing stages.

9 Apply traffic paint for striping and other markings with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates for a 15-mil (0.38-mm) minimum wet film thickness.

10 For Precast Concrete Wheel Stopper: Anchor wheel stopper to substrate with galvanized steel dowels according to manufacturer's written instructions. Fill cores solidly with concrete.

16.3.2 Field Quality Control

1 Engage a qualified independent testing agency to perform the following field quality control testing:
   (a) Samples of material delivered to Project site shall be taken, identified,
sealed, and certified in presence of Contractor.

(b) Testing agency shall perform tests for characteristics specified, using applicable referenced testing procedures or, if not referenced, using tests cited in manufacturer's product data.

(c) Testing agency shall verify thickness of coatings during traffic coating application.

2 If test results show traffic coating materials do not comply with requirements, remove noncomplying materials, prepare surfaces, and reapply traffic coatings.

3 Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

16.3.3 Curing and Protecting

1 Cure traffic coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.

2 Protect traffic coatings from damage and wear during remainder of construction period.
Add the following new Part number 17 “Stone Cladding”

17. STONE CLADDING

17.1 General

17.1.1 Scope

1 This Part includes the following:

(a) Dimension stone panels set mechanically with individual anchors in the building elevations as indicated on Drawings.
(b) Dimension stone panels fixed with wire tie and cement mortar.

2 Related Sections include the following:

(a) Section 1 General
(b) Section 5 Concrete
(c) Section 24 Part 10 Joints, Caulking and Sealants

17.3.2 References

1 The following references are referred to in this Part.

ASTM C 119 Terminology Relating to Natural Building Stones.
ASTM C 880 Test Method for Flexural Strength of Dimensional Stone.

17.3.3 Performance Requirements

1 Design stone anchors and anchoring systems according to ASTM C 1242.

2 Provide dimension stone cladding system capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
(a) Design wind pressure: Base design pressures as per BS 6399, positive and negative, as created by wind on a minimum velocity of 45 m/sec. Allow for impact, suction, up-lift and gusting of wind and take into account the building height and the proximity of adjacent buildings, which could cause an increase to the forces.

3 Provide dimension stone cladding system that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing displacement of stone, opening of joints, overstressing of components, failure of joint sealants and connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night-time sky heat loss.

(a) Temperature Change (Range): 35 deg C, ambient; 70 deg C, material surfaces.

4 Horizontal Building Movement (Interstory Drift): Allow for maximum horizontal building movement equal to quotient resulting from dividing floor-to-floor height at any floor by 400.

5 Shrinkage and Creep: Allow for progressive vertical shortening of building frame equal to 3 mm in 3 m.

6 Safety Factors for Stone: Design dimension stone cladding system to withstand loads indicated without exceeding allowable working stress of stone determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:

(a) Safety Factors for Marble: 5 for uniform loads and 10 for concentrated loads.

7 Design stone anchors and shelving angles to withstand loads indicated without exceeding allowable working stresses established by the following:

(a) For Cold-Formed Stainless Steel: ASCE 8, "Specification for the Design of Cold-Formed Stainless Steel Structural Members."

(b) For Cast-in-Place and Post-installed Fasteners in Concrete: One-fourth of tested capacity when installed in concrete with compressive strength indicated.

(c) For Post-Installed Fasteners in Masonry: One-sixth of tested capacity when installed in masonry units indicated.

9 Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances of building's structural system. Concrete structural fabrication and erection tolerances are specified in Section 5 "Concrete". Structural-steel fabrication and erection tolerances are specified in Section 16 "Structural Steelwork."

10 Provision for Deflection of Building Structure: Allow for the following:

(a) Deflection due to Weight of Dimension Stone Cladding System: Allow for
6-mm vertical deflection in 6-m span of structural members supporting dimension stone cladding system.

(b) Live Load Deflection: Allow for 6-mm vertical deflection, in 6-m span of structural members supporting dimension stone cladding system, due to loads imposed on building's structural frame after stone installation.

11 Submit detailed structural Computations and Shop drawings to indicate values of deflections and methods adopted to accommodate.

12 Control of Corrosion and Staining: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Use materials that do not stain exposed surfaces of stone and joint materials.

17.3.4 Submittals

1 Product Data for each variety of stone, stone accessory, and other manufactured products indicated.

2 Shop Drawings: Showing details of fabrication and installation of dimension stone cladding system, including dimensions and profiles of stone units.

   (a) Show locations and details of joints both within dimension stone cladding system and between dimension stone cladding system and other construction.

   (b) Include details of sealant joints.

   (c) Show locations and details of anchors and shelving angles.

   (d) Include large-scale shaded elevations and details of decorative surfaces and inscriptions.

   (e) For installed dimension stone cladding systems indicated to comply with certain design loads and calculated deflection values limits, include structural analysis data signed and sealed by the qualified structural engineer responsible for their preparation.

3 Stone Samples for Verification: Sets for each colour, grade, finish, and variety of stone required; not less than 300 mm square. Include five samples in each set showing the full range of variations in appearance characteristics expected in the completed Work. Samples shall be approved by Engineer as indicated in this Part and Drawings.

4 Sealant Samples for Verification: For each type and colour of joint sealant required.

5 Qualification Data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience.

6 Material Test Reports from a qualified independent testing agency indicating and interpreting test results of the following for compliance with requirements indicated:
(a) Stone Test Reports for each stone variety proposed for use on Project, provide test data indicating compliance with required physical properties including those specified by reference to ASTM standards. Include test data for flexural strength based on testing according to ASTM C 880, performed on specimens representative of minimum thickness and finish of installed stone, in both wet and dry conditions. Base reports on testing done within previous five years.

(b) Anchorage Test Reports: For each combination of stone variety, and anchor type, based on testing according to ASTM C 1354, performed on specimens representative of minimum thickness and finish of installed stone.

(c) For metal components, indicate chemical and physical properties of metal.

(d) Sealant Compatibility and Adhesion Test Report: From sealant manufacturer complying with requirements in Part 10 "Joint Caulking and Sealants." Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

(e) Preconstruction Sealant Field Test Report: From Installer, complying with requirements in Part 10 "Joint Caulking and Sealants."

17.3.5 Quality Assurance

1 Installer Qualifications: An experienced installer who has completed dimension stone cladding systems similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

(a) Installer's responsibilities include engineering, fabricating, and installing dimension stone cladding system.

2 Structural Engineer Qualifications: A local structural consulting engineer who is legally qualified to practice and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of dimension stone cladding systems that are similar to those indicated for this Project in material, design, and extent.

3 Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

4 Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.

(a) Obtain each variety of stone from a single quarry, whether specified in this Section or in another Section of the Specifications.

5 Source Limitations for Other Materials: Obtain each type of stone accessory, sealant, and other material from a single manufacturer for each product.
6. Preconstruction Stone Testing: Engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by the Contractor. Retesting of materials that fail to meet specified requirements shall be done also at Contractor's expense.

(a) Furnish test specimens randomly selected by testing agency from blocks representative of actual materials proposed for incorporation into the Work.

(b) One set of test specimens will be required for each stone variety, of number and size indicated in referenced standards.

(c) Stone will be tested for compliance with physical property requirements according to referenced ASTM standards.

(d) Flexural Strength Tests: ASTM C 880, performed on specimens representative of minimum thickness and finish of installed stone. One set will be tested in both wet and dry conditions.

(e) Anchorage Tests: ASTM C 1354, performed on specimens representative of minimum thickness and finish of installed stone. One set will be tested for each combination of stone variety, finish, and anchor type.

7. Testing agency will report test results in writing to Engineer and Contractor.

8. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint sealant manufacturers samples of materials that will contact or affect joint sealants, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Section 24, Part 10 "Joint, Caulking and Sealants."

9. Preconstruction Field Testing of Sealants: Before installing joint sealants, field test their adhesion to joint substrates per requirements specified in Part 10 "Joint, Caulking and Sealants."


11. Mock-ups: Before installing dimension stone cladding systems, build mock-ups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated for the completed Work:

(a) Locate mock-ups where indicated or, if not indicated, as directed by Engineer.

(b) Dimension of mock-ups shall be as selected by the Engineer but not more than 4.50 m long and 1.50 m high

(i) Show typical components, attachments to building structure, and methods of installation.

(ii) Include architectural relations to adjoining work items including windows coping, sills and the like.
(iii) Include sealant-filled joint complying with requirements in Part 10 "Joint Caulking and Sealants."

(c) Notify Engineer seven days in advance of dates and times when mock-ups will be constructed.

(d) Obtain Engineer's approval of mock-ups before starting installation.

(e) Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.

(f) Approval of mock-ups does not constitute approval of deviations from the Contract Documents contained in mock-ups unless such deviations are specifically approved by Engineer in writing.

(g) Demolish and remove mock-ups when directed.

(h) Approved mock-ups may become part of the completed Work if undisturbed at time of Substantial Completion.

12 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

17.3.6 Delivery, Storage and Handling

1 Deliver sealants to Project site in original unopened containers labelled with manufacturer's name, product name and designation, colour, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.

2 Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.

(a) Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.

(b) Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.
17.3.7 Project Conditions

1 Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or below 4 deg C or when joint substrates are wet.

17.4 PRODUCTS

17.4.1 Stone, General

1 Varieties and Sources: Subject to compliance with requirements, provide one of the stone varieties indicated on Drawings and in Finishing Schedule.

(a) If descriptions of two or more stone types are identical except for finish, provide the same variety from the same source for each type.

2 For each stone variety, provide matched blocks extracted from a single bed of quarry stratum unless Engineer approves stone from blocks randomly selected for aesthetic effect.

3 Quarry stone in a manner to ensure that as-quarried block orientations yield finished stone with required characteristics.

4 Make quarried blocks available for examination by Engineer for appearance characteristics.

17.4.2 Stone Types


(a) Type: As indicated on Drawings.
(b) Finish: As indicated on Drawings.
(c) Dimensions: As per drawings.
(d) Thickness: As indicated on Drawings.

2 Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without a precoated finish.

3 Granite: Provide granite complying with ASTM C 615.

(a) Type: As indicated on Drawings.
(b) Finish: As indicated on Drawings.
(c) Dimensions: As per drawings.
(d) Thickness: As indicated on Drawings.

17.4.3 Anchors and Shelving Angles

1 Fabricate anchors, including shelf angles, from stainless steel, ASTM A 666, Type 316 L, temper as required to support loads imposed without exceeding
allowable design stresses, sufficiently adjustable vertically and horizontally to meet the specified requirements for accuracy.

(a) Fasteners for Stainless-Steel Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F 738 M for bolts and ASTM F 836 M for nuts, Alloy Group 2 A4

2 Cast-in-Place and Post installed Fasteners for Concrete and Masonry: Type indicated below, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

(a) Post installed Fasteners for Concrete and Masonry: Chemical anchors, torque-controlled expansion anchors, made from stainless-steel components complying with ASTM F 738 M and ASTM F 836 M, Alloy Group A1 or A4 for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

3 Wire Tiebacks: No. 9 AWG copper or copper-alloy wire.

17.4.4 Stone Accessories

1 Setting Buttons: Lead or resilient plastic buttons, non-staining to stone, sized to suit joint thicknesses and bed depths of stone units without intruding into required depths of joint sealants or causing third-side adhesion between sealant and setting button.

2 Setting Shims: Strips of vulcanised neoprene, 50 to 70 Shore A durometer, non-staining to stone, sized to suit joint thicknesses and depths of stone supports without intruding into required depths of joint sealants or causing third-side adhesion between sealant and setting shims.

3 Concealed Sheet Metal Flashing: Fabricate from stainless steel complying with requirements specified in Section 17 "Metalwork" in thicknesses indicated, but not less than 0.4 mm thick.

4 Damp proofing to light-colour Marble: Provide cementitious formulations that are recommended by producer and that are non staining to stone, compatible with joint sealants and noncorrosive to anchors and attachments

6 Sealant Products: Provide manufacturer's standard chemically curing, elastomeric sealants that are compatible with joint fillers, joint substrates, and other related materials and that comply with requirements in Part 10 of this Section for products corresponding to those indicated below:

(a) Sealant for Joints in Dimension Stone Cladding: As follows:
   (i) Single-component, nonsag, low-modulus, urethane sealant.
   (ii) Low-modulus, neutral-curing silicone sealant.

(b) Sealant for Filling Kerfs: As follows:
   (i) Single-component, nonsag, urethane sealant for Use T.
(ii) High-modulus, neutral-curing silicone sealant.

(c) Colours: Provide colours of exposed sealants to comply with the following requirement:
   (i) Provide colour as selected by Engineer from manufacturer’s full range.

7 Cleaner: Stone cleaner specifically formulated for stone types, finishes, and applications indicated, as recommended by stone producer. Do not use cleaning compounds containing acids, caustics, harsh fillers, or abrasives.

17.4.5 Stone Fabrication

1 Fabricate stone units in sizes and shapes required to comply with requirements indicated, including details on Drawings and Shop Drawings.
   (a) For marble, comply with recommendations in MIA’s "Dimensional Stone--Design Manual IV.", for mechanical fixing.
   (b) For granite, comply with recommendations in NBGQA’s "Specifications for Architectural Granite."

2 Cut and drill sinkages, for mechanical fixing, and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place; shape beds to fit supports.

3 Cut stone to produce pieces of thickness, size, and shape indicated and to comply with fabrication and construction tolerances recommended by applicable stone association or, if none, by stone source, for faces, edges, beds, and backs.
   (a) Minimum Thickness for stone mechanically fixed: Provide stone units of not less than highest the following thicknesses:
      (i) Thickness recommended by stone producer for applications indicated.
      (ii) Thickness recommended by stone anchors for applications indicated.
      (iii) Thickness recommended in referenced standards.
      (iv) Thickness indicated on Drawings.
      (v) 40 mm.
   (b) Thickness of Stone Facing fixed with wire tie and cement mortar: Provide thickness not less than the thickest of following:
      (i) Nominal Thickness: 20 mm.
      (ii) Thickness indicated on Drawings

4 Control depth of stone and back check to maintain minimum clearances indicated between backs of stone units and surfaces or projections of structural members, fireproofing (if any), backup walls, and other work behind stone.
(a) Minimum Clearance: As indicated on Drawings.

5 Dress joints (bed and vertical) straight and at right angle to face, unless otherwise indicated.

6 Quirk-mitre corners, unless otherwise indicated; provide for cramp anchorage in top and bottom bed joints of corner pieces.

7 Cut stone to produce joints of uniform width and in locations indicated.

(a) Joint Width: 2.0 mm, unless otherwise indicated on Drawings.

8 Clean backs of stone to remove rust stains, iron particles, and stone dust.

9 Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.

10 Fabricate moulded work, including washes and drips, to produce stone shapes with a uniform profile throughout entire unit length, with precisely formed arris slightly eased to prevent snipping, and with matching profile at joints between units.

(a) Produce mouldings with machines having abrasive shaping wheels made to reverse contour of moulding shape; do not sculpt mouldings.

11 Carve and cut inscriptions according to shaded drawings approved by Engineer. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.

12 Abrasively etch inscriptions according to drawings approved by Engineer.

13 Finish exposed faces and edges of stone, except sawed reveals, to comply with requirements indicated for finish and to match approved samples and mockups.

14 Pattern Arrangement: Fabricate and arrange panels with veining and other natural markings to comply with the following requirements:

(a) Cut stone from one block or contiguous, matched blocks in which natural markings occur.

(b) Arrange panels in blend pattern for granite cladding and with horizontal veining for marble cladding.

15 Carefully inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.

(a) Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colours and other appearance characteristics represented in approved samples and mockups.

16 Finish exposed faces and edges of stone to comply with requirements indicated Drawings and to match approved samples and mockups.
17.4.6 Mortar Materials

1 Portland Cement: complying with ASTM C150.

2 Aggregates: Aggregates shall meet the requirements of ASTM C 144.

3 Water: Potable.

4 Plasticiser: ASTM C260, approved admixture as a workability aid. Use as recommended by manufacturer.

5 Pointing Grout: Shall be latex-Portland cement grout to ANSI A118.6, composed as follows:

   (a) Factory-Prepared, Dry-Grout Mixture: Factory-prepared mixture of Portland cement; dry, redispersible, ethylene vinyl acetate additive; and other ingredients to produce the following:

      (i) Unsanded grout mixture for joint width indicated.

   (b) Colour of grout material shall be selected by the Engineer from manufacturer's full range.

17.4.7 Source Quality Control

1 Source Quality-Control Testing Service: Employ an independent testing agency to perform source quality-control testing. Payment for these services will be made by the contractor. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

2 Tests for compliance with requirements will be performed as follows. Furnish test specimens randomly selected under the supervision of the Engineer from blocks representative of actual materials proposed for incorporation into the Work.

   (a) Flexural Strength Tests: ASTM C 880, performed on specimens representative of minimum thickness and finish of installed stone. One set of test specimens will be required for every 250 sq. m but not fewer than 2 sets for each stone variety.

   (b) Anchorage Tests: ASTM C 1354, performed on specimens representative of minimum thickness and finish of installed stone. One set of test specimens will be required for each combination of stone variety, finish, and anchor type.

3 Testing agency will report test results promptly and in writing to Engineer and Contractor.
17.5 WORKMANSHIP

17.5.1 Examination

1 Examine surfaces to receive dimension stone cladding and conditions under which dimension stone cladding will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

(a) For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of dimension stone cladding.

(b) Proceed with installation only after unsatisfactory conditions have been corrected.

17.5.2 Preparation

1 Advise installers of other work about specific requirements for placement of inserts, flashing reglets, and similar items to be used by dimension stone cladding Installer for anchoring, supporting, and flashing of dimension stone cladding system. Furnish installers of other work with Drawings or templates showing locations of these items.

2 Protect dimension stone cladding during erection as follows:

(a) Cover tops of dimension stone cladding installation with nonstaining, waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 600 mm down both sides and hold securely in place.

(b) Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials without damaging stone.

(c) Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.

(d) Protect sills, ledges, and projections from mortar and sealant droppings.

3 Clean stone surfaces that are dirty or stained by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fibre brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

17.5.3 Setting Dimension Stone Cladding

1 Execute dimension stone cladding installation by skilled mechanics and employ skilled stone fitters at Project site to do necessary field cutting as stone is set.

(a) Use power saws with diamond blades to cut stone. Produce lines cut straight and true, with edges eased slightly to prevent snipping.

2 Contiguous Work: Provide reveals, reglets, and openings as required to accommodate contiguous work.
3 Set stone to comply with requirements indicated on Drawings and Shop Drawings. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure dimension stone cladding in place. Shim and adjust anchors, supports, and accessories to set stone accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.

4 Provide expansion, control, and pressure-relieving joints of widths and at locations indicated.

(a) Sealing expansion and other joints with joint sealants as specified in Part 10 of this Section

(b) Keep expansion joints free of mortar and other rigid materials.

5 Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water to divert water to building exterior.

17.5.4 Installation Tolerance

1 Variation from Plumb: For vertical lines and surfaces of walls, do not exceed 6 mm in 3 m, 9 mm in 6 m, or 12 mm in 12 m or more. For external corners, corners and jambs within 6 m of an entrance, expansion joints, and other conspicuous lines, do not exceed 3 mm in 3 m, 6 mm in 6 m, or 9 mm in 12 m or more.

2 Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 3 mm in 3 m, 6 mm in 6 m, or 9 mm maximum.

3 Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, do not exceed 6 mm in 6 m or 12 mm in 12 m or more.

4 Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 6 mm.

5 Variation in Joint Width: Do not vary joint thickness more than 3 mm in 900 mm or a quarter of nominal joint width, whichever is less.

6 Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1.5-mm difference between planes of adjacent units.

17.5.5 Setting Mechanically Anchored Dimension stone Cladding

1 Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C 1242.

2 Before commencing erection, survey the building structure, including any fixing inserts, and report to the Engineer immediately any inaccuracy preventing proper positioning of units.

3 Fix cladding slabs as follows:
(a) Use 4 restraint anchors per slab. Anchors are to be located preferable at top and bottom of slab and at a distance from edge of slab equal to one fifth total length of slab.
(b) Support cladding units at extreme lower end with continuous load-bearing angles.
(c) Support cladding units using two load bearing anchors per slab at each floor level or at intervals of 3 m height approximately.
(d) Support cladding units at vertical movement joints using two separate load bearing anchors, one at each side of the joint.
(e) Hold fixings in place in supporting concrete members with expansion bolts.
(f) Hold fixings is place in supporting concrete block masonry walls with expansion bolts suitable for the purpose.
(g) Do not exceed torque figures or shim dimensions recommended by manufacturer.

4 Fill anchor holes with sealant.

(a) Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.
(b) Correct irregulations in backing walls hanging shelve angles with non-shrink grout.

5 Set stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of stone a distance at least equal to width of joint.

6 Fill cavities between back of stone units and backup walls for the first two panel rows of stone cladding from finish floor level in ground floor or in most lower floor adjacent to mechanical cladding with cement sand mortar in slurry consistency as specified. Fill at back of each row of stone units starting from bottom one until completion of the two meters high required. Fill in layers not more than 300 mm provided that stone units remain in place without any displacement and allow sufficient time for complete cement setting before pouring the slurry of the successive overlaying layers. Point joints between stone units with colored cement sand mortar as specified. Finish joints flush with adjoining stone surfaces.

17.5.6 Installing Interior Stone Facing And Trim (Thick Wet Bed Method)

1 Erect stone facing and trim plumb and true with uniform joint widths and accurately aligned. Use temporary shims to maintain joint width. Remove shims before pointing.

2 Set stone facing units firmly against setting spots located at anchors and spaced a maximum of 450 mm apart over back of unit, but no less than 1 spot per 0.18 sq. m, unless otherwise indicated.

3 Fixing of stone facing units shall be with thick wet setting grout in the following
sequence:

(a) Establish correct datum line to the floor
(b) Gauge rods are to be set up to indicate the overall measurements of a given number of stone units with specified joint widths
(c) Integral units are to be used throughout
(d) Generally, start fixing from center of the wall and proceed in accordance with shop drawings submitted by the contractor and approved by the Engineer
(e) Joints are to be truly aligned vertically and horizontally and of 1.00 mm width unless otherwise indicated on Drawings or directed by the Engineer
(f) Fix wires to approved details to back of stone units cement fire ends of wires to backing walls using cement sand mortar consisting of 350 kg ordinary Portland cement to each cubic meter of sand with addition of approved accelerating admixture. Addition of gypsum is totally prohibited.
(g) Provide suitable temporary supporting at top of each slab or tile after setting in place to lines, always maintain slabs and tiles plumb, leave cavity between face of backing wall and back of unit not less than 25 mm and not more than 40 mm
(h) After finishing placing and temporary setting of each raw of slabs or tiles, fill cavity behind unit with cement sand slurry as specified at layers not more 300 mm high provided always that slabs or tiles remain in place and allow sufficient time for complete cement setting before pouring the slurry of the successive layer and proceed until filling all required layers
(i) Remove temporary supports and clean face of tiles of mortar splash
(g) Proceed with fixing overlaying next raw in the same sequence.

4 Point joints after setting. Use mortar type and color indicated. Tool joints uniformly and smoothly with plastic tool.

17.5.7 Joint Sealant Installation

1 Prepare joints and apply sealants of type and at locations indicated to comply with applicable requirements in Part 10 "Joint Caulking and Sealants".

17.5.8 Adjusting and Cleaning

1 Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and dimension stone cladding that does not match approved samples and mockups. Damaged stone may be repaired if Engineer approves methods and results.

2 Replace in a manner that result in dimension stone cladding's matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

3 Clean dimension stone cladding as work progresses. Remove mortar fins and...
4 Clean dimension stone cladding no fewer than six days after completion of pointing and sealing, using clean water and stiff-bristle fibre brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone.
Add the following new Part number 18 “Toilet Compartment”

18. TOILET COMPARTMENT

18.1 GENERAL

18.1.1 Scope

1 This Part includes

   (a) Phenolic-core units as follows:

   (i) Toilet Enclosures: Floor anchored.

   (ii) Urinal Screens: Wall hung.

18.1.2 Submittals

1 Product Data: For each type of product indicated.

2 Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

3 Samples for Initial Selection: For each type of unit indicated

4 Samples for Verification: Of each type of colour and finish required for units, prepared on 150-mm square Samples of same thickness and material indicated for Work.

5 Product Data for particleboard, documentation indicating that product contains no urea formaldehyde.

18.1.3 Quality Assurance

1 Document Conflict and Precedence:

   (a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

   (b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

18.1.4 Project Conditions

1 Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.

2 Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating toilet compartments without field measurements. Coordinate wall, floor, ceilings, and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
18.2 MATERIALS

18.2.1 Phenolic-Core Units

1 Door, Panel and Pilaster Construction: Solid phenolic-core panel material with HPL facing on both sides fused to substrate during panel manufacture (not separately laminated), and with eased and polished edges. Provide minimum 13-mm thick doors and pilasters and minimum 13-mm thick panels.

2 Facing Sheet Colour: As selected by Engineer from manufacturer's full range of colours.

3 Core Colour: Manufacturer's standard dark colour.

4 Panel Performance Requirements

   (a) Modulus of elasticity: 100,000 Kg/cm², minimum.
   (b) Shear strength: 140 Kg/cm² minimum.
   (c) Compressive strength: 165 MPa minimum.
   (d) Weight: 1490 Kg/m³, maximum.
   (e) Flame spread (ASTM E-84): Class 1 A (25).
   (f) Non-porous surface and edges.
   (g) Will not support micro-organic growth.
   (h) Resistance to Cigarette Burns: Not affected according to BS EN 438-2.
   (i) Highly resistance to organic chemicals and household chemicals.
   (j) Highly impact resistance according to BS EN 438-2.
   (k) Pilaster Shoes and Sleeves (Caps): Stainless steel, BS EN 10088-2 or ASTM A 666, Type 304 or 316.

18.2.2 Brackets (Fittings):

1 Stirrup Type: Ear or U-brackets, stainless steel.

2 Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

18.2.3 Accessories

1 Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.

2 Material: Stainless steel.

3 Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.
18.2.4 Fabrication

1 Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and levelling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

2 Doors: Unless otherwise indicated, provide 610-mm wide in-swinging doors for standard toilet compartments and 914-mm wide out-swinging doors with a minimum 813-mm wide clear opening for compartments indicated to be accessible to people with disabilities.

  (a) Hinges: Manufacturer's standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.

  (b) Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.

  (c) Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.

  (d) Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.

  (e) Door Pull: Manufacturer's standard unit at out-swinging doors that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

18.3 APPLICATION

18.3.1 Installation

1 Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

2 Maximum Clearances:

  (a) Pilasters and Panels: 13 mm.

  (b) Panels and Walls: 25 mm.

  (c) Stirrup Brackets: Secure panels to walls and to pilasters with not less than three brackets attached at midpoint and near top and bottom of panel.

    (iii) Locate wall brackets so holes for wall anchors occur in masonry or tile joints.

    (iv) Align brackets at pilasters with brackets at walls.
18.3.2 Adjusting

1 Adjust and lubricate hardware according to manufacturer’s written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.
Add the following new Part number 19 “Polymer Modified Cement Waterproofing”

19. POLYMER MODIFIED CEMENT WATERPROOFING

19.1 GENERAL

19.1.1 Summary

1 This Section includes the work of a polymer modified cement-based waterproofing as indicated in the Drawings and specified herein and includes:

(a) Wet areas.

2 Related Sections include the following:

(a) Part 10 "Joint Caulking and Sealant" for elastomeric and preformed sealants in concrete and masonry walls and floors.

19.1.2 Submittals

1 Product Data: Include construction details, and material descriptions and installation instructions for modified cement waterproofing.

2 Shop Drawings: Show locations and details of waterproofing preparation and application. Show expansion joint details and waterproofing application at obstructions and penetrations.

3 Samples: For each type of modified cement waterproofing indicated.

(a) Include Samples of available colour selection.

4 Qualification Data: For Installer and manufacturer.

5 Material Test Reports: For each modified cement waterproofing product.

6 Manufacturer's inspection reports of completed installation.

7 Warranty: Special warranty specified in this Part.

19.1.3 Quality Assurance

1 Applicator Qualifications: An experienced applicator who has completed modified cement waterproofing similar in material, design, and extent to that indicated for this project and whose work has resulted in application with a record of successful in-service performance.

2 Mockups: Provide mockups of modified cement waterproofing to verify selections made under sample submittals and to demonstrate aesthetic effects.

(a) Engineer will select locations of mockups that represent typical surfaces and conditions for applications of modified cement waterproofing.

(i) Vertical/Horizontal Surfaces: Provide samples of at least 1.0 sq. m.
(b) Apply waterproofing according to requirements for the completed Work after permanent lighting and other environmental services have been activated.

3 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer

19.1.4 Project Conditions

1 Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit modified cement waterproofing to be performed according to manufacturer’s written instructions and warranty requirements.

2 Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after concrete and masonry substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.

3 Proceed with waterproofing work only if temperature is maintained at 4°C or above but less than 32°C during work and cure period and space is well ventilated and kept free of water.

19.1.5 Warranty

1 Manufacturer’s standard form in which manufacturer and installer agrees to repair or replace components of modified cement waterproofing that fail in materials or workmanship within specified warranty period.

(a) Failures include, but are not limited to, the following:

(i) Failure to maintain watertight conditions within specified warranty period.

(ii) Bond failure.

(b) Warranty Period: Five (5) years from the date of Substantial Completion.

19.2 PRODUCTS

19.2.1 Materials

1 Flexible, Cement Based Waterproof Coating for Wet Areas: Prepackaged flexible, polymer modified cement based waterproof coating. Composed from a blend of Portland cement, selected silica, micro-fibres and modifying agents for mixing with potable water. Properties of Cured Waterproofing:

(a) Tensile Strength: 0.9 N/mm² after 28 days, according to EN 1542.

(b) Adhesive Strength: 1.1 N/mm after 28 days.
(c) Elongation: 45%, minimum.
(d) Water Resistance:
   (i) Positive Pressure: 1.5 bar, minimum.
(e) Crack bridging: Up to 0.50 mm for membrane of 2 mm thick, according to EN 1062-7 Method A static.

19.2.2 Proportion and Design of Mixes

1 Prepackaged, Modified Cement Waterproofing:
   (a) Add prepackaged dry ingredients to mixing liquid according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.

19.3 EXECUTION

19.3.1 Examination

1 Examine walls, floors, and other surfaces where waterproofing is to be applied for compliance with requirements for surface preparation, cleaning, and other conditions affecting water proofing performance.
   (a) Proceed with application only after unsatisfactory conditions have been corrected. Application of waterproofing indicates acceptance of surfaces and conditions.

19.3.2 Preparation

1 Protect other work from fallout or overspray from modified cement waterproofing during application. Provide temporary enclosure to confine spraying operation, to prevent polluting the air, and to ensure adequate ambient temperatures and ventilation conditions for application.

2 Stop active water leaks according to waterproofing manufacturer’s written instructions.

3 Repair damaged or unsatisfactory concrete or masonry according to manufacturer's written instructions.

4 Comply with waterproofing manufacturer’s written instructions to remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to concrete or masonry surfaces.
   (a) Clean masonry surfaces according to ASTM D 4261.
   (b) Clean concrete surfaces according to ASTM D 4258.
      (i) Prepare smooth-formed and trowel-finished concrete by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
   (c) Concrete Joints: Clean reveals according to waterproofing manufacturer's written instructions.
19.3.3 Application

1 Comply with waterproofing manufacturer’s written instructions, unless more stringent requirements are indicated.

   (a) Dampen surface with water and maintain damp condition until applying waterproofing

   (b) Number of Coats: As recommended by manufacture, but not less than 2, with maximum application thickness of 1.5 mm per coat for total thickness of 3 mm.

      (i) Apply first bond coat as slurry with brush or stiff broom, and subsequent coats with brush, spray, or trowel to specified surface finish.

      (ii) Dampen surface between coats.

2 Curing: Air-cure waterproofing.

3 Moist-cure waterproofing for three days immediately after application has set, followed by two days of air drying as recommended in writing by manufacturer.

   (a) Moist-cure waterproofing when temperatures are above 29 deg C, relative humidity is below 30 percent, wind speed exceeds 24 km/h, or waterproofing is exposed to direct sunlight for 72 hours after placement.

4 Extend waterproofing treatment as follows:

   (a) Onto columns integral with treated walls.

   (b) Onto interior non-treated walls intersecting exterior treated walls, for a distance of 600 mm for cast-in-place concrete and 1200 mm for masonry.

   (c) Onto exterior walls and onto both exterior and interior columns, for a height of 300 mm, where floors, but not walls, are treated.

   (d) Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps, and similar offsets and features.

5 Finishing:

   (a) Surfaces indicated as to be trowelled smooth shall be finished with a steel trowel to a smooth surface, free of trowel marks.

   (b) Surfaces indicated to receive plaster shall be scratched in the two directions to provide a key for the plastering.

19.3.4 Protection

1 Protect applied, modified cement waterproofing from rapid drying, severe weather exposure, and water accumulation. Maintain completed Work in moist condition for not less than seven days by covering with impervious sheeting or by other curing procedures recommended in writing by waterproofing manufacturer.
19.3.5 Field Quality Control

1. Inspection: Manufacturer's representative to inspect completed application and to provide a written report that application complies with manufacturer's written instructions.
Add the following new Part number 20 “Bituminous Dampproofing”

20. BITUMINOUS DAMPPROOFING

20.1 SUMMARY
1. This Section specifies Cold-applied, emulsified-asphalt dampproofing.
2. See Section 7 for GSAS requirements.

20.2 SUBMITTALS
1. Product Data: For each type of product indicated indicating VOC content.

20.3 QUALITY ASSURANCE
1. Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

20.4 PROJECT CONDITIONS
1. Proceed with installation only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers’ written instructions.
2. Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

20.5 MATERIALS

20.5.1 Cold-Applied, Emulsified-Asphalt Dampproofing
1. Trowel Coats: ASTM D 1227, Type II, Class 1.
2. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

20.5.2 Miscellaneous Materials
1. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.

20.6 APPLICATION
1. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
2. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.
3 Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.

4 Apply additional coats if recommended by manufacturer or if required to achieve coverages indicated.

5 Allow each coat of dampproofing to cure min. 6 hours before applying subsequent coats.

6 Apply dampproofing to provide continuous plane of protection on exterior face of inner wythe of exterior masonry cavity walls.

7 For Dimension Stone Cladding: Apply primer and 1 brush or spray coat at not less than 0.4 L/sq. m.

8 Remove dampproofing materials from surfaces not intended to receive dampproofing.
Add the following new Part number 21 “Smoke Curtain”

21. SMOKE CURTAIN

21.1 GENERAL

1 This Part includes the following:

(a) An electrically operated automatic fire barrier, to be used to form a continuous barrier against smoke produced in a fire.

21.2 PERFORMANCE REQUIREMENTS

1 Complete product tested to (BS) EN12101-1:2005 and BS7346: Part 3, and achieved a rating of DA (600°C, above 120 minutes) and is ASB 1 and 3 classified.

2 Designed to operate for 2000 cycles at normal ambient temperatures in the range of 0°C to 60°C and to withstand hot air and smoke at temperatures up to 600°C for over 120 minutes.

3 The fabric has a class 1 surface spread of flame when tested to BS 476: Part 7 and a fire propagation index I =1.4 when tested to BS 476: Part 6.

21.3 SUBMITTALS

1 Product Data: Include durability, laundry temperature limits, fade resistance, and fire-test-response characteristics for each type of curtain fabric indicated.

(a) Include data on each type of applied curtain treatment.

2 Shop Drawings: Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.

(a) Include details on blocking above ceiling and in walls.

3 Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

(a) Suspended ceiling components.
(b) Structural members to which suspension systems will be attached.

4 Samples for Initial Selection: For each type of curtain material indicated.

5 Samples for Verification: For each type of product required, prepared on Samples of size indicated below.
(a) Curtain Fabric: 305-mm square swatch or larger as required to show complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.

(b) Curtain Track: Not less than 102 mm long.

(c) Curtain Carrier: Full-size unit.

6 Curtain and Track Schedule: Use same designations indicated on Drawings.

7 Manufacturer Certificates: Signed by manufacturers certifying that products comply with requirements.

8 Operation and Maintenance Data: For curtains, track, and hardware to include in operation and maintenance manuals.

21.4 QUALITY ASSURANCE

1 Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

(a) Build mockup of typical cubicle, complete with track, curtain, as shown on Drawings.

(i) Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Ministry Representative in writing.

(ii) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

2 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

21.5 PRODUCTS

1 Curtain Fabric: is manufactured from woven glass fibre cloth more even surface and allows a tighter interlacing of the fabric edges, and is tested to withstand temperatures of up to 1000°C for a period of 60 minutes

(a) Pattern: As indicated on Drawings, unless otherwise as selected by Engineer.

(b) Colour: As indicated on Drawings, unless otherwise as selected by
Engineer.

(c) Weight: 540 gm/m², minimum.

2 Smoke Curtain: The curtain head box is manufactured from 1.2 mm galvanised steel, the enclosure is rated at the same temperature as the curtain fabric. Removable cover plates are incorporated to allow access to the curtain rollers.

3 A suitably weighted bottom bar is provided to prevent deflection and ensure correct operation under gravity. A polycarbonate extrusion is supplied as standard, this locates into the profile formed in the bottom of the box.

4 The roller is constructed from an tube, each of which incorporates a 24volt d.c. motor & gearbox and a sealed heavy duty ball bearing assembly. A motor control circuit housed in a steel enclosure is mounted onto the motor end of the head box.

21.6 ACCESSORIES

1 Voice warning: Audio or spoken multi message facility.

2 Beam protection and obstruction warning: A beam detector, with delay timer which will sound in the event of any obstruction being placed in the barrier drop line.

3 Visual alert system: Standard localized light or strobe light.

4 Emergency retract: Hold on retract facility for multi escape and emergency service access.

5 Walk through escape: Passage through the barrier.

21.7 CURTAIN SAFETY DEVICE

1 Provide safety device, speed sensitive; in the event of an over-speed situation (greater than 0.5 m per second) caused by malfunction of the hoisting apparatus, whether sudden or gradual, device will immediately activate. Safety device will work regardless of direction of rotation and automatically resets when load is reversed or removed.

21.8 CONTROLS

1 Provide key lock, 3-position, momentary contact wall control switch to lower, raise.

2 Refer to Section 22 “Building management System”

3 The system must be proven to fail safe to the operational position on total loss of primary and auxiliary power. Under normal operating conditions the curtains would be held in the retracted position via the motors operating at low voltage. The manufacturer must be able to confirm that themotor windings used are suitable for this type of operation. Upon activation of the fire alarm the control panel will remove the supply voltage and the curtain will descend under the power ofgravity in a controlled manner. A dynamic braking system housed in the
motor control circuit controls the speed of descent of the curtain, this is electronically synchronised on overlapping curtains with a common bottom bar.

4 The curtain control panel shall be supplied by 24v to supply the motors drive the curtains to the upper position. In case the mains power fail to the group control panel the supply is automatically switched to the integral standby battery. The curtain remains in the retracted position for 1 hour (fully loaded system). The curtain will remain fully operational until the battery low voltage cut off facility reads a voltage of 21v.

21.9 EXECUTION

1 Preparation

(a) Field verify dimensions prior to fabrication.

(b) Coordinate electrical requirements for motorized operating mechanism to ensure proper power source, conduit, wiring, and boxes for keyed switches. Prior to installation, verify type and location of power supply.

2 Installation

(a) Install in accordance with manufacturer's written instructions and shop drawings.

(b) Install even and level with curtain hanging 50 mm above floor in down position.

(c) Install control switch such that operator has view of complete gymnasium divider during lowering and raising.

(d) Adjust limit switches of electric winch to ensure accurate position in both stored and lowered positions.

3 Testing and Demonstration

(a) Operate curtains to ensure proper lifting and lowering. Adjust as required to ensure smooth operation and accurate positioning.

(b) Demonstrate to Owner's designated representatives complete operation and required maintenance.
Add the following new Part number 22 “Wooden Base”

22. WOODEN BASE

(a) Are to be constructed from hardwood, species to be as indicated on drawings.

(b) Fabricate to dimensions and details indicated.

(c) Furnish in length as long as practice.

(d) Corners are to be mitered at 45 degrees.

(e) Finish of bases shall be transparent stained varnish as specified in “Painting”.
Add the following part 23 “Glassfiber Reinforced Plastic (GRP)”

23 GLASSFIBER REINFORCED PLASTIC FABRICATIONS (GRP)

23.1 GENERAL

23.1.1 Related Documents

1. Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.

23.1.2 SUMMARY

1. This Section includes the following:

   (a) Custom designed GRP screen of dimension, design, patterns and other aesthetic characteristics as indicated on Drawings.

23.2 PRODUCT

1. GRP Ladders: Fiberglass-composite ladders or railings made of pultruded tubing with internal reinforcement, where needed, to support a point load of 150 kg at middle of rung. Rungs are to be coated with abrasive material for slip resistance. Safety cages are also made from fiberglass-composite materials. Ladders shall comply with OSHA PP 1910.27 and installed to supplier’s specifications. Products shall be designed with a 3 to 1 safety factor.

   (a) Ultimate Tensile Strength: 206 Mpa

   (b) Ultimate Compressive Strength: 206 Mpa

   (c) Construction: fiberglass content minimum 60 % glass content by weight.

23.3 EXECUTION

23.3.1 Examination

1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting performance.

   (a) Proceed with installation only after unsatisfactory conditions have been corrected.

23.3.2 Installation

1. Installing GRP materials in accordance to approved shop drawings

23.3.3 Adjusting and Cleaning

1. After completion of installation, inspect exposed finishes and repair damaged finishes.
2. Comply with written instructions of GRP manufacturer for adjusting and cleaning.
24. STRETCHED FABRIC CEILING SYSTEMS

24.1 GENERAL

24.1.1 Summary

1 This Part includes Stretched ceiling systems complete with concealed tracks and all other accessories for installation.

1 Related Sections include the following:

(a) Section 21 electrical sections for light fixtures and other electrical components penetrate ceiling system.

24.1.2 Submittals

1 Product Data: For each type of frame and core material specified.

2 Shop Drawings: Include attachment devices; seaming diagrams; and details at head, base, joints, corners and intersections with shelves, doors, electrical outlets and switches, thermostats, and other components. Indicate frame edge and core materials.

(a) Include reflected ceiling plans showing panel sizes and direction of fabric weave.

3 Coordination Drawings: Show relation of stretched-fabric systems to other attached ceiling types.

4 Test Reports: Submit test data from an independent testing agency, acceptable to authorities having jurisdiction, evidencing that the ceiling system assembly comply with specified requirements.

5 Qualification Data: For Installer.

6 Samples for Verification: For the following products. Prepare Samples from the same material to be used for the Work.

(a) Fabric: Full-width by 1000-mm long Sample from dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of fabric.

(b) Frame System: 300-mm long Sample showing edge profile and corner.

(c) Portable mockup of complete installation, no larger than 1000 by 1000 mm. Show joints at seams.

7 Maintenance Data: Include fabric manufacturers cleaning and stain-removal recommendations.
24.1.3 Quality Assurance

1 Installer Qualifications: An experienced installer who employs workers trained and approved by stretched-fabric system manufacturer to install manufacturer's products.

2 Mockups: Before installing stretched-fabric systems, install mockups for each type of system and finish required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Install mockups to comply with the following requirements, using materials indicated for the completed Work:
   (a) Install mockups in the location as directed by Engineer.
   (b) Install mockup of typical ceiling area as shown on Drawings.
   (c) Notify Engineer seven days in advance of dates and times when mockups will be installed.
   (d) Demonstrate the proposed range of aesthetic effects and workmanship.
   (e) Obtain Engineer's approval of mockups before starting installation of stretched-fabric systems.
   (f) Maintain mockups during installation in an undisturbed condition as a standard for judging the completed Work.
   (g) Demolish and remove mockups when directed.
   (h) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

3 Document Conflict and Precedence:
   (a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.
   (b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

24.1.4 Storage

1 Comply with fabric manufacturer's written instructions for minimum and maximum temperature and humidity requirements for storage.

24.1.5 Project Conditions

1 Environmental Limitations: Do not install stretched-fabric systems until spaces are enclosed and weatherproof, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
2 Field Measurements: Verify dimensions by field measurements.

### 24.1.6 Warranty

1 **General Warranty**: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

2 **Special Warranty**: Written warranty, signed by stretched-fabric system manufacturer agreeing to repair or replace stretched-fabric systems that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, fabric sagging, distorting, or releasing from frame edge.

   (a) **Warranty Period**: Ten years from date of Substantial Completion.

### 24.2 PRODUCTS

#### 24.2.1 Stretched-Fabric Ceiling Systems

1 **General**: Provide Flexible PVC (polyvinyl chloride) base membrane ceiling sheet; cadmium free, custom produced to suit exact field measurement.

   (a) **Thickness**: 0.17 mm, minimum.

2 **Profile**: As indicated on Drawings.

3 **Vapour Barrier**: Comply according to BS 3177.

4 **Fire-Test-Response Characteristics**: Class “0”, according to BS 476 Part 6 & 7.

5 **Mechanical Features**:

   (a) **Tear Strength**:
      (i) 196.50 kg/sqcm, longitudinal
      (ii) 220.80 kg/sqcm, Transversal

   (b) **Tensile strength at Rupture**:
      (i) 1.6 dN, longitudinal
      (ii) 2.0 dN, transversal.

   (c) **Elongation at rupture accordance with NFT 54102**
      (i) 230%, longitudinal
      (ii) 300%, transversal.

   (d) **Light reflection**: 81%, approximate

   (e) **Light Transmission**: 10%, approximate
(f) Air Tightness: 100%.

(g) Sound Absorption Rating: 0.6, according to ASTM C423-01.

(h) NRC: 0.62, according to ASTM C423-01.

(i) Finish:
   (i) Lacquer: Matt.
   (ii) Colour to be selected by Engineer from the full range of manufacturer.

(j) Frame System: Concealed rails, manufacturer standard; extruded aluminium.

24.2.2 Accessories

1 Provide all other special pieces and fittings necessary for perfect and neat installations.

2 Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.

(a) Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching frames of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
   (i) Type: Postinstalled expansion anchors.
   (ii) Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

24.2.3 Fabrication

1 Stretched ceiling membrane shall be hooked into the framing system without any gluing or clips.

2 Reinforcement: PVC rings, to suit shape and size of lighting fixtures, sprinklers and any other features fixed in stretched ceiling membrane.

3 Membrane sheets will be connected together by factory welds to achieve appropriate size.

24.3 EXECUTION

24.3.1 Examination

1 Examine fabric, substrates, and conditions, with Installer present, for compliance with requirements, installation tolerances, air infiltration, and other conditions
affecting performance of stretched-fabric systems.

2 Proceed with installation only after unsatisfactory conditions have been corrected.

24.3.2 Installation

1 Install materials in accordance the manufacturer’s instructions.

2 Install stretched-fabric systems vertical and plumb, if applicable; true in plane; and with fabric installed square to the grain. Match and level fabric pattern and grain.

3 Sewn seams will not be permitted.

4 Acclimatize Fabric: Before installation, allow fabric to adjust to and become stable at ambient temperature and humidity of spaces where it will be installed.

5 Stretch fabric tight and square without puckers, ripples, or distortions. Repair sagging. Gluing or stapling is not permitted.

6 Install fabric with patterns or directional weaves fabricated so pattern or weave matches adjacent panels.

7 Examine fabric as it is installed for damage, imperfections, poor colour match, or other deficiencies. Replace with accepted material as directed by Engineer.
25. HIGH PRESSURE LAMINATE FLOORING

25.1 HIGH PRESSURE LAMINATE FLOORING

1 Composition:

(a) Surface layer: High-pressure laminate (HPL) decorative, resin-based wear-resistant melamine with two or three additional layers and aluminium oxide for maximum wearing resistance to be of grade AC5 at least according to EPLF.

(b) Core: High Density Fibre board (HDF), moisture resistant.

(c) Joints: Glue free double click system/ Smart Lock. Impregnated tight joint construction.

(d) Backing: Glass fibre under lay glued to back of planks.

(e) Panel Dimension: As indicated on Drawings.

(f) Thickness: 11.00 mm minimum

(g) Colour and Pattern: As selected by Engineer, unless otherwise indicated on Drawings.

2 Performance: The following table indicates the minimum of performance properties requirements:

<table>
<thead>
<tr>
<th>Description</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class of use</td>
<td>Class 34 to EN 685</td>
</tr>
<tr>
<td>Wear resistance</td>
<td>&gt;9000 to EN 13329, Annex F</td>
</tr>
<tr>
<td>Scratch resistance</td>
<td>Very high</td>
</tr>
<tr>
<td>Indentation Resistance</td>
<td>No Damage, according to EN425</td>
</tr>
<tr>
<td>Castor chairs</td>
<td>No Damage to EN 425</td>
</tr>
<tr>
<td>Dimensional stability</td>
<td>&lt; 0.9 %</td>
</tr>
<tr>
<td>Electrostatic charge</td>
<td>2.0 kV to EN 1815</td>
</tr>
<tr>
<td>Fire classifications</td>
<td>Bfs1 according to EN 13501</td>
</tr>
<tr>
<td>Density core material</td>
<td>910kg/m³</td>
</tr>
<tr>
<td>Resistance to burning cigarettes</td>
<td>Class 5, according to EN438</td>
</tr>
<tr>
<td>Slip Resistance</td>
<td>DS, according to EN 14041</td>
</tr>
</tbody>
</table>
25.1.1 Accessory Materials

1 Where indicated to match laminate flooring, provide laminate baseboard moulding, base shoe moulding and stair risers (if any) of same species and grade as Laminate flooring. Except as otherwise indicated, provide skirting, quarter round and expansion profile of same species and grade.

2 Trowelable Levelling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by wood flooring manufacturer.

3 Fasteners: As recommended by manufacturer

4 Cork Expansion Strip: Composition cork strip.

25.2 EXECUTION

25.2.1 Inspection

1 Examine substrates on which Laminate flooring will be installed and conditions under which work shall be performed.

   (a) Verify that substrates comply with tolerances and other requirements specified in other Sections.

   (b) Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

2 Substrate Moisture Testing, General: Perform tests recommended by manufacturer.

25.2.2 Preparation

1 Grind high spots and fill low spots on concrete substrates to produce a maximum 3-mm deviation in any direction when checked with a 3-m straight edge.

2 Use trowelable levelling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

3 Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

25.2.3 Installation

1 General: Comply with flooring manufacturer's instructions and recommendations.

2 Pattern: Comply with pattern or direction of pattern for laying wood flooring as indicated on approved shop drawings.

3 Installation of Laminate Flooring:

   (a) Sequence of laying wood strips shall be dependent on the composition of the pattern as indicated on shop drawings approved by the Engineer.
(b) Strips shall be laid so that tongues fit grooves tightly. Tongues shall be fixed into position by tapping with a hammer.

(c) Completed laminate flooring shall be level, flat, and free from irregularities. Permitted clearance between laminate strips shall not exceed 0.2 mm.

25.2.4 Protection

1 Protect completed Laminate flooring during remainder of construction period with heavy Kraft paper or other suitable covering so that flooring and finish shall be without damage or deterioration at time of substantial completion.
26. SOLID-SURFACE MATERIAL FABRICATIONS

26.1 MATERIALS

1 Solid polymer components

(a) Cast, nonporous, filled polymer, not coated, laminated or of composite construction with through body colors, composed of acrylic resin and other natural materials, meeting ANSI Z124.3 or ANSI Z124.6, having minimum physical and performance properties specified.

2 Performance characteristics:

<table>
<thead>
<tr>
<th>Property</th>
<th>Typical Result</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>6,000 psi</td>
<td>ASTM D 638</td>
</tr>
<tr>
<td>Tensile Modulus</td>
<td>1.5 x 10-6 psi</td>
<td>ASTM D 638</td>
</tr>
<tr>
<td>Tensile Elongation</td>
<td>0.4% min.</td>
<td>ASTM D 638</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>10,000 psi</td>
<td>ASTM D 790</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>1.2 x 10-6 psi</td>
<td>ASTM D 790</td>
</tr>
<tr>
<td>Hardness</td>
<td>&gt;85</td>
<td>Rockwell &quot;M&quot; Scale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM D 785</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Barcol Impressor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASTM D 2583</td>
</tr>
<tr>
<td>Thermal Expansion</td>
<td>3.02 x 10-5 in./in./°C</td>
<td>ASTM D 696</td>
</tr>
<tr>
<td>Gloss (60° Gardner)</td>
<td>5–75 (matte—highly polished)</td>
<td>ANSI Z124</td>
</tr>
<tr>
<td>Light Resistance</td>
<td>(Xenon Arc) No effect</td>
<td>NEMA LD 3-2000</td>
</tr>
<tr>
<td>Method 3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wear and Cleanability</td>
<td>Passes</td>
<td>ANSI Z124.6 &amp;</td>
</tr>
<tr>
<td>Z124.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stain Resistance: Sheets</td>
<td>Passes</td>
<td>ANSI Z124.3 &amp;</td>
</tr>
<tr>
<td>Z124.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungus and Bacteria</td>
<td>Does not support microbial growth</td>
<td>ASTM G21&amp;G22</td>
</tr>
<tr>
<td>Resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiling Water Resistance</td>
<td>No visible change</td>
<td>NEMA LD 3-2000</td>
</tr>
<tr>
<td>Method 3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Temperature Resistance</td>
<td>No change</td>
<td>NEMA LD 3-2000 Method 3.6</td>
</tr>
<tr>
<td>Izod Impact</td>
<td>0.28 ft.-lbs./in. of notch</td>
<td>ASTM D 256</td>
</tr>
</tbody>
</table>


Weatherability \( \Delta E^{94}<5 \) in 1,000 hrs.  ASTM G 155

Specific Gravity † 1.7

Water Absorption Long-term 0.6% (1/2”)

Flammability Class A ASTM E 84, NFPA 255 & UL 723

Flame Spread Index <25

Smoke Developed Index <25

3 Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:

(a) As selected by Engineer from manufacturer’s full range.

26.2 FACTORY FABRICATION

26.2.1 Shop assembly

1 Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer’s printed instructions and technical bulletins.

2 Form joints between components using manufacturer’s standard joint adhesive without conspicuous joints.

3 Provide factory cutouts for fittings and accessories as indicated on the approved shop drawings.

4 Rout and finish component edges with clean, sharp returns.

(a) Rout cutouts, radii and contours to template.

(b) Smooth edges.

(c) Repair or reject defective and inaccurate work.

26.2.2 Thermoforming:

1 Comply with manufacturer’s data.

2 Heat entire component.

(a) Material shall be uniform, between 275 and 325 degrees Fahrenheit during forming.

3 Form pieces to shape prior to seaming and joining.

4 Cut pieces to finished dimensions.

5 Sand edges and remove nicks and scratches.
26.3 COUNTERS

1 Grade: Premium.

2 Solid-Surfacing-Material Thickness: 13 mm.

3 Fabricate exposed surfaces in one piece. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

4 Counters units shall be pre-fabricated units constructed to dimensions and details indicated on Drawings.

5 Provide metal pre-slotted shelf holders of baked enamel finish complete with removable brackets for shelf supporting. Color is to be to the selection of the Engineer.

6 Provide manufacturer's standard hardware including hinges, drawer slides, latches and knobs of finish to the selection of the Engineer. All hardware shall be manufactured from stainless steel, alloy 304, of satin finish.

7 Blocking wood shall be from approved hardwood type.

26.4 STONE PANELING AND COLUMN FACING

1 Arrange panels in shop or other suitable space in proposed orientation and sequence for examination by Engineer. Mark units with temporary sequence numbers to indicate position in proposed layout.

   (a) Lay out one elevation at a time if approved by Engineer.
   (b) Notify Engineer seven days in advance of date and time when layout will be available for viewing.
   (c) Provide lighting of similar type and level as that of final installation for viewing layout, unless otherwise approved by Engineer.
   (d) Rearrange panels as directed by Engineer until layout is approved.
   (e) Do not trim non-modular-size units to less than modular size until after Engineer's approval of layout, unless otherwise approved by Engineer.
   (f) Mark backs of units and Shop Drawings with sequence numbers based on approved layout. Mark backs of units to indicate orientation of units in completed Work.

2 Nominal Thickness: 20 mm, unless otherwise indicated.

3 Joints: 1.5-mm wide grouted, unless otherwise indicated.

4 Quirk-miter corners, unless otherwise indicated. Install anchorage in top and bottom bed joints of corner units.

5 Carve and cut inscriptions and decorative surfaces according to Shop Drawings. Use skilled stone carvers experienced in the successful performance of work similar to that indicated.
6 Alternative in paragraph below is less expensive than above; it also does not have depth of relief of above.

7 Abrasively etch inscriptions and decorative surfaces according to Shop Drawings.

8 Laser etching in paragraph below produces virtually no relief but can be used to reproduce photographic images on polished stone.

9 Pattern Arrangement: Fabricate and arrange panels with veining and other natural markings to comply with the following requirements:

(a) Arrange panels with veining as indicated on Drawings.

26.5 EXECUTION

26.5.1 Examination

1 Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

26.5.2 Preparation

1 Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.

26.5.3 Installation

1 Install solid surfacing components plumb, level, and true according to approved shop drawings and manufacturer’s published installation instructions. Use woodworking and specialized fabrication tools acceptable to manufacturer.

26.5.4 Repairs

1 If permissible by Engineer, minor surface marring for solid surfacing components may be repaired according to manufacturer’s published installation instructions.

2 Remove and replace solid surfacing components that are damaged and cannot be satisfactorily repaired.

26.5.5 Cleaning and Protection

1 Clean solid surfacing components according to manufacturer’s published maintenance instructions. Completely remove excess adhesives and sealants from finished surfaces.

2 Protect completed work from damage during remainder of construction period.
Add the following part “Playground Surface Protective Surfacing”

27 PLAYGROUND SURFACE PROTECTIVE SURFACING

27.1 GENERAL

27.1.1 Summary

1 Rubber flooring for playground area

27.1.2 Submittals

1 Product Data: For each type of product indicated. Include material descriptions and construction details for each component of playground surface system.

2 Shop Drawings: For each playground surface system, include materials, cross sections, drainage, installation, penetration details, and edge termination, loose fill edgings, including border edge tiles, patterns made by varying colors of surfaced and details of graphics.

3 Coordination Drawings: Layout plans and elevations drawn to scale and coordinating installation of playground surface systems with playground equipment. Show playground equipment locations, use zones, fall heights, extent of protective surfacing, and Critical Heights.

4 Color Samples for Initial Selection: Manufacturer’s color charts or 150-mm squares of units showing the full range of colors and textures available for components with factory-applied color finishes.

5 Color Samples for Verification: For the following products, for each type of exposed finish required, prepared on Samples of size indicated below and of same thickness and material indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

(a) Minimum 150-by-150-mm-square sample of non-loose fill surfacing.
(b) 150 mm long by full-size, cross-section border edge tile.
(c) Minimum 150-mm-long sample of loose fill edging.

6 Product Certificates: Signed by manufacturers of playground surface systems certifying that surfacing furnished comply with requirements.

7 Product Test Reports: From a qualified testing agency indicating playground surface system complies with requirements, based on comprehensive testing of current products.

8 Material Test Reports: From a qualified testing agency indicating material complies with requirements.
27.1.3 Delivery, Storage, and Handling

1. Deliver manufactured materials in original packages with seals unbroken and bearing manufacturer's labels indicating brand name and directions for storing.

2. Store manufactured materials in a clean, dry location, protected from the weather and deterioration, and complying with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

27.1.4 Coordination

1. Coordinate construction of playground surface systems with installation of playground equipment, including accurate use zones.

27.1.5 Warranty

1. Written warranty from Contractor agreeing to repair or replace components of synthetic flooring that fails in materials and workmanship within 5 years from the date of substantial completion.

27.2 PRODUCTS

27.2.1 Playground Surface Systems, General

1. Accessibility: Provide playground surface systems determined to be accessible when tested according to ASTM PS 83.

   (a) Colors: As selected by Engineer from manufacturer's full range

27.2.2 Primer Coats

1. Repair for all playground sub base, as per manufacturer instructions, composed of patch binder to adhesion concrete and/or asphalt sub base and to use as a specific primer coat in order to reinforce the superficial cohesion of mix asphalts.

2. Trowelable, leveling, Portland cement based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

27.2.3 Rubber Flooring

1. Descriptions

   (a) Polyurethane Primer: Single-component, designed specifically for use in priming concrete prior to installation of polyurethane coating. And also used for priming cured polyurethane prior to application of new coating.

   (b) Base Layer Granules: Recycled black SBR rubber, processed and graded to (1 -4) mm in size, containing less than 4 percent dust.

   (c) Thickness: minimum 13 mm, sufficient to meet IAAF requirements

   (d) Pore Sealer: Granules colored EPDM rubber granules processed and graded to (0.0 – 0.5) mm in size, containing less than 4 percent dust and polyurethane coating.
(e) Top Coat Layer: Colored, EPDM rubber granules, processed and graded (0.0 – 0.5) in size unless otherwise specified. Provide rubber containing minimum of 20 percent EPDM and approved by resin manufacturer.

(f) Thickness: minimum 2mm, sufficient to meet IAAF requirements

(g) Finish Sealer Coat: Polyurethane self-leveling, colored coat, containing no Solvents Designed to Give Sealed Finish Surface.

27.3 EXECUTION

27.3.1 Examination

1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for sub grade and substrate conditions, for compliance with playground surface system manufacturer's requirements, and for other conditions affecting performance.

2 Proceed with installation only after unsatisfactory conditions have been corrected.

27.3.2 Preparation

1 Stake locations of playground perimeter, playground equipment, use zones, and pathways. Clearly indicate locations of utilities, lawn sprinkler system, subgrade drainage systems, and underground structures.

2 General: Prepare fill, patch, clean remove high spots and ridges, remove incompatible coatings from substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound without high spots, ridges, holes, and depressions.

27.3.3 Installation, General

1 General: Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated and as required to comply with specified requirements for impact-attenuation performance and, where indicated, for accessibility.

2 Seamless Surface: Mix and apply components of playground surface system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface and impact-attenuating system of total thickness indicated. Proportion each blend of resilient particulate material with binder, in ratio complying with manufacturer's written instructions. Mix components thoroughly to form a uniform dispersion. Coordinate application of components to provide optimum adhesion of playground surface system. Cure successive applications of components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

3 Where colored pattern is indicated, place adjacent colored material as soon as placed colored material is sufficiently cured using primer or adhesive if required by manufacturer's written instructions.
27.3.4 Cleaning and Protection

1 Prevent traffic over system for not less than 48 hours after installation. Protect playground surface system from damage and wear during the remainder of construction period. Clean playground surface system after time period recommended in writing by playground surface system manufacturer.

END OF PART
SECTION 25

GLASS AND GLAZING
1. GENERAL

*Add the following new Clauses:*

1.2 QUALITY ASSURANCE

1.2.1 Source Limitations for Glass
1. Obtain glass through one source from a single manufacturer for each glass type.

1.2.2 Source Limitations for Glazing Accessories
1. Obtain glazing accessories from one source for each product and installation method indicated.

1.2.3 Glass Product Testing
1. Obtain glass test results from a qualified testing agency.

1.2.4 Glass Testing Agency Qualifications
1. Testing agency shall be an independent testing agency approved by Engineer, with the experience and capability to conduct the testing indicated.

1.2.5 Elastomeric Glazing Sealant Product Testing
1. Test silicone-based elastomeric glazing sealants and other elastomeric glazing sealants for compliance with requirements specified by reference to BS EN ISO 11600 or ASTM C920.

2. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

3. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

1.2.7 Safety Glass
1. Glass conforming to testing requirements of BS EN 12600. Class of impact resistant for any application is to be as specified or a stipulated in BS 6262-4.

2. Any glass panes or lites installed at height of 0.80 meter and below (Low Glazing) shall be of Class A impact resistance.

1.3 DELIVERY, STORAGE, AND HANDLING

1. Protect glazing materials according to manufacturer’s written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

2. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer’s written recommendations for venting
and sealing to avoid hermetic seal ruptures.

1.4 ENVIRONMENTAL LIMITATIONS

1 Contractor shall not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
2. **GLASS**

2.1 **GENERAL GLASS TYPES AND GLAZING**

2.1.2 References

*Add the following standards:*

- BS 4255-1 Rubber used in preformed gaskets for weather exclusion from buildings. Specification for non-cellular gaskets
- BS 5713 Specification for hermetically sealed flat double glazing units
- BS EN ISO 11600 Building construction jointing products. Classifications and requirements for sealants
- ASTM D4802 Standard Specification for Poly (Methyl Methacrylate) Acrylic Plastic Sheet

*Add the following new sub-clauses:*

2.1.3 Performance Requirements

1 General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

2 Loading Requirements: submit calculation sheets showing that the specified glass can withstand the actual loading requirements in respect of:

   (a) Thickness
   (b) Kind of heat treatment
   (c) Safety

3 Glass Design: Glass thicknesses indicated on Drawings are minimum and are for detailing only. Confirm glass thickness by analysing Project loads and in-service conditions.

   (a) Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.
   (b) Glass Thickness: Select minimum glass thickness to comply with BS 6262 or approved European equivalent

4 Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and night-time-sky heat loss.

   (a) Temperature Change (Range): 35 deg C, ambient; 70 deg C, material surfaces.
5 All glass configurations are minimum and should be verified structurally by specialized Contractor.

2.2 GLASS TYPES AND REQUIREMENTS

2.2.1 General Requirements

Add the following new sub-clauses:

4 Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in this part.

5 Provide Kind FT (fully tempered) glass lites where safety glass is indicated.

   (a) Thickness 10 mm.

2.2.4 Mirror Glass

Replace the last sentence at the end of paragraph no. 1 with the following:

"Mirror edges shall be polished levelled".

Add the following new paragraphs:

2 Comply with BS EN 1036

3 Fix mirror accurately and securely without overtightening fasteners, to provide a flat surface giving a distortion free reflection.

4 Miscellaneous Materials

   (b) Setting Blocks: Elastomeric material with a Type A Shore durometer hardness of 85, plus or minus 5.

   (c) Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

   (d) Clips: Stainless steel fixed bottom clips and adjustable top clips with resilient backing.

   (e) Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished colour and texture where fasteners are exposed.

   (f) Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.2.8 Anti-Bandit Glass

Add the following new paragraph:

2 Thickness and lamination of the pane to be recommended and specified by a special manufacture to comply with burglar resistance category of (P5A) when tested in accordance with DIN EN356B.
2.2.9 Toughened Glass

**Amend Class B to Class A in Sub-Clause 1**

**Add the following new paragraphs:**

2. Fabrication: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.

3. Erect all holes opening, and grinding in glass prior to tempering. Edges are to be worked prior to tempering.

**Add the following new sub-clauses:**

2.2.10 Heat-Strengthened Glass

1. Comply with BS EN 1863.

2.2.11 Primary Float Glass

1. Clear, transparent float glass to BS 952-1 and BS EN 572-2, of flat and parallel surfaces so that they provide clear undistorted vision and reflection.

2.2.12 Coated Float Glass

1. Pyrolytic-Coated Float Glass: BS 1096, float glass with metallic-oxide coating applied by pyrolytic deposition process during initial manufacture, and complying with other requirements specified.

2. Sputter-Coated Float Glass: BS 1096, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.

2.2.13 Laminated Glass

1. Laminated Glass: BS EN ISO 12543, and complying with other requirements specified and with the following:

   (a) Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

   (b) For polyvinyl butyral interlayers, laminate lites in autoclave with heat plus pressure.

   (c) Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.

2. Fire Resistant Laminated Glass (GL-3): proprietary fire resistant glass with special intumescent interlayers laminated with float glass. Thickness of glass as recommended for particular purpose by the glass manufacturer to suit window or door area and fire rating required.

3. Laminated Safety Glass (GL-4, GL-7, GL-8, GL-9, GL-10): comply with BS 952-1 and BS 952-2 impact performance to BS 6206, Class A for kinds of laminated glass indicated and other requirements specified or otherwise indicated. Refer to
primary and heat-treated glass requirements relating to properties of glass products comprising laminated glass products.

### 2.2.14 Insulating Glass Units

1. Insulating Glass Units: BS EN 1279 or ASTM E 774.

### 2.2.15 Glass Designation (GL-1):

2. Main Glass Type: Double Insulated Flat Glass, Façade Glazing:

   (a) Panel make-up:
      (i) Outer pane: Heat strengthened laminated blue grey tinted glass 9.14 mm thick (4mm tinted glass + 1.14mm Acoustical PVB + 4mm tinted glass) with solar control and Low-e coatings on face # 2.
      (ii) Inter space: 16mm, dehydrated 100% air gap.
      (iii) Inner pane: Fully tempered safety Clear glass 6mm thick.

   (b) Performance:
      (ii) Shading Coefficient: 0.17, maximum.
      (iii) Light Transmission: 22%, Average.
      (iv) Indoor Light Reflectance: 12%, maximum.
      (v) Outdoor Light Reflectance: 12%, maximum.
      (vi) Energy Transmittance: 10%, maximum.
      (vii) Sound Reduction Rw/STC: 38 db, minimum.

### 2.2.16 Glass Designation (GL-1b):

1. Main Glass Type: Double Insulated Flat Glass, Façade Glazing:

   (a) Panel make-up:
      (i) Outer pane: Heat strengthened laminated blue grey tinted glass 9.14 mm thick (4mm tinted glass + 1.14mm Acoustical PVB + 4mm tinted glass) with solar control and Low-e coatings on face # 2.
      (ii) Inter space: 16mm, dehydrated 100% air gap.
      (iii) Inner pane: Fully tempered safety Clear glass 6mm thick fully deep sand blasted on face #5.

   (b) Performance:
      (ii) Shading Coefficient: 0.17, maximum.
      (iii) Light Transmission: 22%, Average.
      (iv) Indoor Light Reflectance: 12%, maximum.
      (v) Outdoor Light Reflectance: 12%, maximum.
      (vi) Energy Transmittance: 10%, maximum.
2 Skylight glazing:

2.2.17 Glass Designation (GL-1c)

1 Skylight Glass: Double Insulated Glass, Inward Sloped and Horizontal Skylight Glazing:

(a) Panel make-up:
   (i) Outer pane: Fully tempered clear glass 8mm thick with solar control Low-e coating on face # 2, with neutral color.
   (ii) Inter space: 16mm, dehydrated 100% air gap.
   (iii) Inner pane: Fully tempered laminated clear glass 9.52mm thick (4mm clear safety glass + 1.52mm Acoustical PVB + 4mm clear glass) with 50% coverage of ceramic frit, high resolution micro stencil printing black dots (diameter of dots not to exceed 1mm) on face # 4 as per sample approval.

(b) Performance:
   (ii) Shading Coefficient: 0.16, maximum.
   (iii) Light Transmission: 20%, average.
   (iv) Indoor Light Reflectance: 8%, maximum.
   (v) Energy Transmittance: 8%, maximum.
   (vi) External Energy Reflectance: 20%, minimum.
   (vii) Sound Reduction $R_w$/STC: 38 db, minimum.

2 Spandrel glazing (GL-2): Provide spandrel glass fabricated from double glass unit to match Gl-1. Provide shadow box construction from behind unless otherwise indicated.

2.2.18 Monolithic Acrylic Glazing

1 Uncoated Monolithic Cell-Cast Acrylic Sheet: ASTM D 4802, Category A-1, Type UVF (UV filtering), Finish 1 (smooth or polished).

   (a) Nominal Thickness: 5 mm, unless otherwise indicated.
   (b) Transparent Colour: As selected by Engineer from manufacturer's full range.

2.2.19 Back-Painted Glass

1 Glass Painting: Apply acrylic epoxy glass paint to second glass surface and cure according to manufacturer's standard process. Comply with the following requirements:
(a) Coating Adhesion: ASTM D3359, 5 of 5
(b) Scratch Test: ASTM D 2197, Pass.
(c) UV Resistant
(d) Salt Spray: ASTM C 1503, Pass 600 hours.
(e) Thickness: As indicated on Drawings.

2 Connectors: Stainless steel plated fixed bottom connectors and adjustable top connector with resilient backing.

2.2.20 Spandrel single flat glass (GL-11)

1 Fully tempered clear glass 8mm thick with shadow box.
4. GLAZED CURTAIN WALLING SYSTEMS

4.1 GENERAL

4.1.1 Scope

Amend to be read as follows:

1. This Part specifies the requirements, components and workmanship for glazed curtain walling systems including required operable openings.

Amend title of sub-clause 4.2.5 to be Quality Assurance, as indicated hereafter.

4.2.5 Quality Assurance

Add the following new paragraphs:

2. Quality System: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.

3. Manufacturer Qualifications: Curtain wall assemblies shall be designed and fabricated by a manufacturer who has the following minimum qualifications:

   (a) Manufacturer shall have 20 years of successful experience in design and fabrication of special curtain wall assemblies for prestigious projects worldwide of same standard of quality as that intended for the Project, aesthetic effects indicated on Drawings and performance specified.

   (b) Manufacturer shall be reputable of multi-national scale in design and fabrication of special curtain wall systems with capabilities to complete the work at completion dates stated in approved Construction Schedule.

   (c) Manufacturer shall have permanent branch company or legal local representative office.

4. Installer Qualifications: Structural sealant glazed curtain wall assemblies are to be installed with manufacturer's trained experienced specialized staff.

   (a) Engineering Responsibility: Preparation of data for structural-sealant-glazed curtain-wall systems including the following:

      (i) Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.

      (ii) Shop Drawings, Project-specific preconstruction-testing program development, and comprehensive engineering analysis by a qualified professional engineer.

      (iii) Quality-control program development and reporting complying with ASTM C 1401 recommendations including, but not limited to, system material qualification procedures, preconstruction sealant-testing program, and procedures and intervals for system fabrication and installation reviews and checks Shop Drawings based on testing and
Engineering analysis of mockup.

5 Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.

(a) Build mockup of typical wall area as indicated by Engineer.

(b) Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.

6 Testing Agency Qualifications: Engage an independent agency qualified according to ASTM E 699 for testing indicated. Testing include:

(a) Preconstruction structural glazing sealant testing.

(b) Mockup testing.

(c) Preconstruction secondary sealant testing.

(d) Field testing of Permanent Works.

7 Product or Design Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

(a) Do not modify intended aesthetic effects, as judged solely by the Engineer, except with Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to the Engineer for review.

8 Preconstruction Secondary Sealant Testing: Perform sealant manufacturer's standard tests for compatibility and adhesion of sealants with each material that will come in contact with sealants and each condition required by curtain-wall systems.

(a) Test a minimum of five samples of each metal, glazing, and other material.

(b) Prepare samples using techniques and primers required for installed systems.

(c) Perform tests under environmental conditions that duplicate those under which systems will be installed.

(d) For materials that fail tests, determine corrective measures required to prepare each material to ensure compatibility with and adhesion of sealants, including, but not limited to, specially formulated primers. After performing these corrective measures on the minimum number of samples required for each material, retest materials.

9 Preconstruction Testing Service: Engage a qualified independent testing agency to test glazed curtain-wall systems for compliance with specified requirements for performance and test methods. Provide test specimens and assemblies representative of proposed materials and construction.
(a) Select sizes and configurations of assemblies to adequately demonstrate capability of glazed curtain-wall systems to comply with performance requirements and according to AAMA 501 recommendations.

(b) Before performing testing, remove at least one of every type of glazing panel from each test specimen and replace them using reglazing procedures required for systems specified.

(c) Notify Engineer seven days in advance of the dates and times when assemblies will be constructed.

10 Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code--Aluminium".

11 Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.

12 Preinstallation Conference: Conduct conference at Project site to review methods and procedures related to glazed curtain-wall systems including, but not limited to, the following:

(a) Review structural load limitations.

(b) Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

(c) Review required testing, inspecting, and certifying procedures.

(d) Coordination with work of other trades.

13 Document Conflict and Precedence:

(a) Notify Engineer prior to submitting proposal in the case of conflict among Documents, including Drawings and Specifications.

(b) The strictest interpretation shall govern in the case of conflict between and/or among Drawings and specifications, unless noted otherwise in writing by Engineer.

4.2.6 Delivery, Storage and Handling

Add the following new paragraphs:

4 Comply with manufacturer’s recommendations for delivery, storage and handling of curtain walls.

5 Delivery: Deliver factory-finished curtain walls components to Site with factory-applied wrapping. Wrapping shall be easily removable type without defacing of finished surfaces.

6 Storage: Store curtain wall components in clean, neat storage area, protected from direct sunlight and rains, raised off-ground with wood blocking between different layers of components. Space supporting blocking at a spacing to prevent deflection, sagging or any deformation in components.

7 Handling: Handle curtain wall components in a manner that do not cause
abrasion, scratching or deterioration for factory-finished components.

4.2.7 General Warranty

**Amend paragraph no.3 to be read as follows:**

3 The warranty period: Twenty (20) years from date of Substantial Completion.

4.2.8 Special Finish Warranty

**Amend paragraph no.2 to be read as follows:**

2 Special Finish Warranty Period: Twenty (20) years from date of Substantial Completion.

4.3 Structural Glazing

**Add the following new sub-clauses as follows:**

4.3.4 Framing Materials

1 Aluminium: Alloy and temper recommended by manufacturer for type of use and finish indicated.

   (a) Sheet and Plate: ASTM B 209M.
   (b) Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221M.
   (c) Extruded Structural Pipe and Tubes: ASTM B 429.
   (d) Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

2 Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

   (a) Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
   (b) Cold-Rolled Sheet and Strip: ASTM A 611.
   (c) Hot-Rolled Sheet and Strip: ASTM A 570/A 570M.
   (d) Brackets and Reinforcements: Manufacturer's standard high-strength aluminium with non-staining, nonferrous shims for aligning system components.

3 Fasteners and Accessories, Generally: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

   (a) Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   (b) Reinforce members as required to receive fastener threads.
   (c) Use exposed fasteners with countersunk Phillips screw heads.
(d) Finish exposed portions to match adjoining surfaces
(e) At movement joints, use slip-joint linings, spacers, and sleeves of stainless steel and type recommended by the manufacturer.

4 Anchors: Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by the manufacturer.

(a) Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

5 Concealed Flashing: Dead-soft, 0.457-mm thick stainless steel, ASTM A 240/A 240M of type recommended by manufacturer.

6 Framing Gaskets: Silicon-compatible as recommended by glazing sealant manufacturer. Shapes and sizes are to be as recommended by the manufacturer for joint type.

4.3.5 Glazing Systems

1 Infill Panels

(a) Glass Systems:
   (i) Glazing and Spandrel Panels: Types as indicated on Drawings and as specified in this Section Part 1.
   (ii) Spacers, Setting Blocks, Gaskets, and Bond Breakers: As specified in this Section

(b) Composite Aluminium Panels:
   (i) Comply with requirements as indicated on Drawings and specified in Section 17 Part “Light Metal Support and Cladding System”.

2 Spacers, Setting Blocks, Gaskets, and Bond Breakers: As specified in this Section.

3 Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other system components with which it comes in contact; and recommended by structural- and weatherseal-sealant and curtain-wall manufacturers for this use.

   (a) Joint Movement Capability: Accommodates a 50 percent increase or decrease in joint width at time of application when measured according to ASTM C 719.
   (b) Colour: As selected by the Engineer from manufacturer's full range.

4 Structural Sealant: ASTM C 1184, neutral-curing silicone formulation compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant, and approved by structural-sealant manufacturer for use in curtain-wall systems indicated.
(c) Colour: Black.
(d) Type: Manufacturer's standard single or two component.
(e) Minimum Tensile Strength: 690 kPa.
(f) Modulus of Elasticity: As required by structural-sealant-glazed curtain-wall system design to meet performance requirements.

4.3.6 Operable Units

1 Doors: As specified in Section 17 "Metal Works."

4.3.7 Accessory Materials

2 Insulating Materials: Specified in Section 15 "Thermal Insulation of Buildings."
3 Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 0.762 mm thickness per coat.

4.3.8 Fabrication

1 Form metal shapes before finishing.
2 Fabricate components that, when assembled, have the following characteristics:
   (a) Sharp profiles, straight and free of defects or deformations.
   (b) Accurately fitted joints with ends coped or mitred.
   (c) Physical and thermal isolation of glazing from framing members.
   (d) Accommodations for thermal and mechanical movements of glazing and framing to prevent glazing-to-glazing contact and to maintain required glazing edge clearances.
   (e) Structural-sealant joints that do not carry gravity loads of glazing.
   (f) Provisions for field replacement of glazing from exterior. Include accommodations for using temporary support device (dutchman) to retain glazing in place while sealant cures.
3 Weld in concealed locations to greatest extent possible to minimize distortion or discolouration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

4 Factory-Assembled Frame Units:
   (a) Rigidly secure nonmovement joints.
   (b) Seal joints watertight, unless otherwise indicated.
   (c) Pressure equalize system at its interior face.
   (d) Factory glazing is recommended for structural-sealant-glazed curtain-wall systems; it is essential for four-sided systems. Verify with manufacturers selected.
(e) Install glazing to comply with requirements in this Section Part "Glazing." Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

5 After fabrication, clearly mark components to identify their locations in Project according to approved shop drawings.

4.3.9 Aluminium Finishes

1 General: Comply with requirements as specified in Section 17 Part 2.

4.4 INSTALLATION

4.4.6 Field Quality Control

Add the following new paragraphs as follows:

2 Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports as specified.

3 Testing Services: Testing and inspecting of representative areas to determine compliance of installed systems with specified requirements shall take place as follows and in successive stages as indicated on Drawings. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.

(a) Structural-Sealant Compatibility and Adhesion: Structural sealant shall be tested according to recommendations in ASTM C 1401.

(i) Destructive test method, Method A, Hand Pull Tab (Destructive) in ASTM C 1401, Appendix X2 shall be used.

1) A minimum of six areas on each building face shall be tested.

2) Repair installation areas damaged by testing.

(b) Water Spray Test: After the installation of minimum area of 23 m by full building height structural-sealant-glazed curtain-wall system has been completed but before installation of interior finishes has begun, a 2-bay area of system designated by Engineer shall be tested according to AAMA 501.2 and shall not evidence water penetration.

4 Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

5 Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

Add the following new sub-clauses as follows:

4.4.10 Erection Tolerances

1 Install structural-sealant-glazed curtain-wall systems to comply with the following maximum tolerances:
(a) Plumb: 3 mm in 3 m; 6 mm in 12 m.
(b) Level: 3 mm in 6 m; 6 mm in 12 m.
(c) Alignment:
   (i) Where surfaces abut in line or are separated by reveal or protruding element up to 13 mm wide, limit offset from true alignment to 1.6 mm.
   (ii) Where surfaces are separated by revealing or protruding element from 13 to 25 mm wide, limit offset from true alignment to 3.2 mm.
   (iii) Where surfaces are separated by reveal or protruding element of 25 mm wide or greater, limit offset from true alignment to 6 mm.
(d) Location: Limit variation from plane to 3 mm in 3.7 m; 13 mm over total length.
5. **ALL-GLASS ENTRANCES**

*Add the following part*

5.1 **GENERAL**

5.1.1 **Scope**

1. All Glass entrance with all glass sliding door, electrically operated

5.1.2 **Definitions**

1. AAADM: American Association of Automatic Door Manufacturers.

2. Activation Device: Device that, when actuated, sends an electrical signal to the door operator to open the door.

3. Safety Device: Device that, to avoid injury, prevents a door from opening or closing.

4. For automatic door terminology, refer to BHMA A156.10 and BHMA A156.19 for definitions of terms.

5.1.3 **Submittals**

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Shop Drawings: For automatic entrances. Include plans, elevations, sections, details, hardware mounting heights, and attachments to other work.

   (a) For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

   (b) Wiring Diagrams: For power, signal, and control wiring.

   (c) Activation and safety devices.

   (d) Include hardware schedule and indicate hardware types, functions, quantities, and locations.

3. Samples for Initial Selection: For units with factory-applied colour finishes.

4. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

5. Qualification Data: For Installer, manufacturer and certified inspector.

6. Product Certificates: For each type of emergency-exit automatic entrance, from manufacturer.
7. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for automatic entrances.

8. Field quality-control reports.

9. Maintenance Data: For automatic entrances, safety devices, and control systems to include in maintenance manuals.

10. Warranties.

5.1.4 Quality Assurance

1. Manufacturer Qualifications: A firm experienced in manufacturing items specified in this section similar to those indicated for this Project and with a record of successful in-service performance for not less than 10 years, as well as sufficient production capacity to manufacture required units.

2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project and who employs a certified inspector with experience not less than 5 years.

3. Source Limitations for Automatic Entrances: Obtain automatic entrances from single source from single manufacturer.

4. Electrical Components, Devices, and Accessories: Listed and labelled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


6. Emergency-Exit Door Requirements: Comply with requirements of authorities having jurisdiction for automatic entrances serving as a required means of egress.

7. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   
   (a) Build mockup of in the locations and of size as directed by Engineer. Show typical components, attachments to building structure, and methods of installation.

   (b) Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

   (c) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

   (d) Demolish and remove mockups when directed unless approved to become part of the completed Work.

   
   (a) Review methods and procedures related to automatic entrances including, but not limited to, the following:

   (i) Structural load limitations.
(ii) Construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

(iii) Coordination with electrical, glazing, and other trades.

(iv) Required testing, inspecting, and certifying procedures.

5.1.5 Project Conditions

1. Field Measurements: Verify actual dimensions of openings to receive automatic entrances by field measurements before fabrication.

5.1.6 Coordination

1. Templates: Obtain templates for doors, frames, and other work specified to be factory prepared for installing automatic entrances, and distribute to parties involved. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic entrances to comply with indicated requirements.

2. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.

3. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies.

5.1.7 Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.

   (a) Failures include, but are not limited to, the following:

      1) Structural failures including, but not limited to, excessive deflection.

      2) Faulty operation of operators, controls, and hardware.

      3) Deterioration of metals, and other materials beyond normal weathering and use.

   (b) Warranty Period: 10 years from date of Substantial Completion.

5.1.9 MATERIALS

1. Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent), tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials.

   (a) Class 1: Clear.

   (b) Thickness: Minimum 12 mm, unless higher thickness is indicated on Drawings.

2. Aluminum: ASTM B 221 (ASTM B 221M), with strength and durability characteristics of not less than alloy 6063-T5.
3. Stainless-Steel Cladding: ASTM A 666, Type 302 or 304.

5.1.10 Door Operators and Activation and Safety Devices

1. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.

   (a) Door Operator Performance: Provide door operators that will open and close doors and maintain them in fully closed position when subjected to Project’s design wind loads.

2. Combination Motion/Presence Sensors: Self-contained units; consisting of both motion and presence sensors in a single metal or plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.

   (a) Motion Sensor: K-band-frequency, microwave-scanner units; with relay hold time of not less than 2 to 10 seconds.
       1) Provide capability for switching between bidirectional and unidirectional detection.

   (b) Presence Sensor: Infrared-scanner units; with relay hold time of not less than 2 to 10 seconds. Sensors shall remain active at all times.

   (c) Access Control: Comply with requirements as specified in Section 21 “Electrical Works.”

5.1.11 Hardware

1. General: Heavy-duty hardware units in sizes, quantities, and types recommended by manufacturer for all-glass entrances indicated. For exposed parts, match fitting metal and finish.

2. Automatic Locking for Sliding Door: Electrically controlled device mounted in header that automatically locks door against sliding when in closed position. Provide fail secure operation if power fails.

3. Motorized Operator: UL-approved, high-starting torque, reversing motor and adjustable speed operator with thermal-overload protection. Include fusible link release to disengage operator and to allow door to close automatically


5.1.12 Fabrication

1. Provide holes and cutouts in glass to receive hardware, fittings, rails, and accessories before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.

2. Fully temper glass using horizontal (roller-hearth) process and fabricate so, when installed, roll-wave distortion is parallel with bottom edge of door or lite.
3. Cutting and punching of glass shall precede tempering

4. Factory assemble components and factory install hardware to greatest extent possible.

5. Activation and Safety Devices:
   (a) General: Factory install devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.

5.1.13 Execution

1. Examination
   (a) Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
   (b) Proceed with installation only after unsatisfactory conditions have been corrected.

2. Installation
   (a) Install all-glass systems and associated components according to manufacturer's written instructions.
   (b) Set units level and plumb.
   (c) Maintain uniform clearances between adjacent components.
   (d) Lubricate hardware and other moving parts according to manufacturer's written instructions.
   (e) Set, seal, and grout floor closer cases as required to suit hardware and substrate indicated.

3. Adjusting and Cleaning
   (a) Adjust doors and hardware to produce smooth operation and tight fit at contact points and weather stripping.
   (b) Remove excess sealant and glazing compounds and dirt from surfaces.
SECTION 26

PAINTING AND DECORATING
1 GENERAL

1.1 GENERAL INTRODUCTION

1.1.2 References

*Add the following standard to the list of standards referred to in the Section:*

BS 6150 Code of practice for painting of buildings

1.2 SUBMITTALS AND SAMPLES

*Delete its entirely content and replace it with the following:*

1 Product Data: For each paint system indicated. Include block fillers and primers.
   
   (a) Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalogue number and general classification.

2 Samples for Initial Selection: For each type of finish-coat material indicated.
   
   (a) After colour selection, Engineer will furnish colour chips for surfaces to be coated.

3 Samples for Verification: For each colour and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
   
   (a) Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colours when preparing Samples for review. Resubmit until required sheen, colour, and texture are achieved.
   
   (b) Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
   
   (c) Submit 4 Samples on the following substrates for Engineer's review of colour and texture only:
       
       (i) Concrete: 100-by-150-mm Samples for each colour and finish.
       
       (ii) Concrete Unit Masonry: 150-by-250-mm Samples of masonry, with mortar joint in the center, for each finish and color.
       
       (iii) Painted Wood: 300-mm square Samples for each color and material on hardboard.
       
       (iv) Stained or Natural Wood: 150-by-250-mm Samples of natural- or stained-wood finish on representative surfaces.
       
       (v) Ferrous Metal: 100-mm square Samples of flat metal and 150-mm long Samples of solid metal for each color and finish.
       
       (vi) Gypsum board: 150-by-250-mm Samples for each finish and color.

4 Qualification Data: For the manufacture and the applicator.
1.3 DELIVERY, STORAGE, HANDLING AND PRODUCT MARKING

1.3.1 Marking of Containers

*Add the following to the list of information to be labelled on sealed containers of materials delivered to the site:*

- (h) Thinning instructions.
- (i) VOC content.

*Add the following new paragraphs:*

4 Store materials not in use in tightly covered containers in a well-ventilated area. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

5 Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing and application.

*Add the following new clauses:*

1.4 QUALITY ASSURANCE

1 Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

2 Source Limitations: Obtain paints, block fillers and primers for each coating system from the same manufacturer as the finish coats.

3 Benchmark Samples (Mock-ups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Duplicate finish of approved sample Submittals.

  (a) Engineer will select one surface to represent surfaces and conditions for application of each type of coating and substrate.

  (i) Wall Surfaces: Provide samples on at least 9 sq. m.

  (ii) Small Areas and Items: Engineer will designate items or areas required.

(b) Apply benchmark samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, colour, and texture on each surface.

(c) Final approval of colours will be from benchmark samples.

4 Submit Manufacturers' product data for paints and coatings, including printed statement of VOC content and chemical components and material safety data sheets.
1.5 FIELD QUALITY CONTROL

1 The Contractor shall engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the project shall be taken, identified, sealed, and certified in the presence of the Contractor.

2 The testing agency will perform on site and laboratory tests for the following characteristics as required by the Board.
   
   (a) Film thickness tests.
   
   (b) Quantitative materials analysis.
   
   (c) Apparent reflectivity.
   
   (d) Washability.
   
   (e) Dry opacity.

3 The Contractor shall remove paint that does not comply with specified requirements, remove rejected paint from previously painted surfaces. Repaint rejected surfaces and pay for retesting.

4 The Owner reserves the right to invoke a testing agency to perform same tests indicated here above.

1.6 CLEANING

1 Daily Cleaning: at the end of each work day, remove empty cans, rags, cleaning pads, rubbish, and other discarded paint materials from the site.

2 Final cleanup: After completion of painting work in each building space, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces or to generate dust. Use material recommended by paint manufacture for cleaning. All surfaces to be cleaned include every exposed surface in the space such as walls, floors, ceilings, ledges, sills, soffits, surfaces of fixed equipments and accessories, conduits, wires, ducts and the like.
2 SURFACE PREPARATION FOR PAINTING

2.1 GENERAL

2.1.2 References

*Add the following standard to the list of standards referred to in the Section:*

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 6150</td>
<td>Code of practice for painting of buildings</td>
</tr>
</tbody>
</table>

2.2 GENERAL PREPARATIONS

2.2.1 Preparation

*Add the following new paragraphs:*

5 Preparation generally shall comply with requirements BS 6150 and printed instructions of the manufacturer.

6 Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

7 Test moisture content of surfaces using an electronic moisture meter. Do not begin application of coatings unless moisture content of exposed surfaces (either new or bare) is in accordance with the manufacturers written recommendations.

2.2.2 Preparatory Materials

*Add the following new paragraphs:*

6 Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with each another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

7 Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

   (a) Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

   (b) Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

   (c) Use only thinners approved by paint manufacturer and only within recommended limits.
Amend Title of sub-clause 2.3 to be “Preparation of Plastered and Rendered Surfaces” as indicated hereafter:

2.3 PREPARATION OF CEMENT PLASTERED AND RENDERED SURFACES

2.3.1 Execution and Workmanship

Add the following new paragraphs:

6. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods similar to abrasive blast-cleaning methods if recommended by paint manufacturer.

7. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer’s written instructions.

2.4 PREPARATION OF WOOD SURFACES

2.4.1 Execution and Workmanship

Add the following new paragraphs:

8. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and panelling.

9. Seal tops, bottoms, and cut-outs of un-primed wood doors with a heavy coat of varnish or sealer immediately on delivery.

10. Back prime panelling on interior partitions where masonry, plaster, or other wet wall construction occurs on back side.

2.5 PREPARATION OF METAL SURFACES

2.5.1 Execution and Workmanship

Add the following new paragraphs:

5. Ferrous Metals: Clean un-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC’s recommendations.

6. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pre-treatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
3 PRIMERS, PAINTING AND COATINGS

3.1 GENERAL REQUIREMENTS

3.1.1 References

Add the following standard to the list of standards referred to in the Section:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS 6150</td>
<td>Code of practice for painting of buildings</td>
</tr>
</tbody>
</table>

3.2 APPLICATION

3.2.1 General

Add the following new paragraphs:

6 Application of primers, paints and coatings generally shall comply with requirements of BS 6150 and printed instructions of manufacturers. Paint shall be with a low VOC contents and to be environmentally-green product which contributes to reducing energy consumption in cooling interiors and reducing urban heat island effect.

7 Furnish additional coats to the number specified in the painting systems so as to produce the required finishes.

8 Review sections in which primers are specified to ensure compatibility of the total system for various substrates.

9 Prime Coats: Apply prime coat of material which is required to be painted or finished and which has not been prime coated by others. Re-coat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat to assure a finish coat with no burn-through or other defects due to insufficient sealing.

10 Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, colour, appearance and coverage. Sand surfaces smooth prior to applying primer and after applying putty. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, roughness or other surface imperfections will not be acceptable.

11 Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even lustre. Provide a finish free of laps, runs, cloudiness, colour irregularity, brush marks, orange peel, nail holes, or other surface imperfections.

3.4 PAINTS AND FINISH COATINGS

Delete in its entirety content and replace it with the following:

3.4.1 Materials and Paint Systems

1 Unless otherwise referenced, employed paint and stain materials for painting work shall conform to the applicable requirements of BS 6150. The employed paint or coating material for each application shall be the highest grade in manufacturer’s range for each generic kind of paint or coating. The terms “render”
2. Primers, undercoats, fillers and stopping materials shall be compatible types produced by the manufacturer of the finish coat or certified by manufacturers as compatible with finishing materials. Unless otherwise specified, no. of coats will be as recommended by the manufacturer.

3. Exterior Paint Schedule:

(a) For Concrete and Cement Plastered Surfaces: Acrylic Paint System: Shall be 100% acrylic water based binder to provide textured surfaces, excellent color retention, UV resistant, very durable, independently tested to have crack bridging up to 1 mm, and also tested for carbon dioxide diffusion, chloride ion diffusion water vapor transmission and liquid water transmission.

   (i) Chemical resistance: Resistant to spillage of gasoline, diesel, sewage, weak acids and alkalis.

   (ii) Primer and intermediate coatings shall be the manufacture written recommendations.

(b) Ferrous Metal and Zinc-Coated Metals: Polyurethane Based Coating System shall be Aliphatic Polyurethane to produce excellent and colour retention coating, applied on epoxy primer and high molecular-weight epoxy intermediate coat. Comply with the following:

   (i) Appearance: Gloss, semi–gloss or matt as directed by the Engineer.

   (ii) Primer and intermediate coatings shall be the manufacture written recommendations.

(c) Wood Works

   (i) Clear Varnish: one- component polyurethane varnish for interior applications, and two-component aliphatic polyurethane varnish for exterior applications, gloss or matte as directed by the Engineer.

   (ii) Stained Woodwork:

      1) Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

      2) Stain Coats: High quality wood stain based on a special Penetrating Alkyd oil to penetrates deep into the wood and ensures effective and lasting protection

      3) Finish Coats: Urethane modified alkyd resin, clear, fast drying and gives an exclusive durable finish.

4. Interior Paint Schedule:

(a) Concrete, Cement Portland Plaster and Gypsum Board Surfaces: Provide the following finish system:

   (i) Pure Acrylic copolymer Emulsion Paint with low VOC to produce a durable, and flexible coating, suitable for repeated washing and scrubbing and of color retention properties and high hiding ability.
1) Primer and intermediate coatings shall be the manufacture written recommendations.

(ii) Pure Acrylic Paint 1 coat primer and 2 Top coats anti-bacterial paint

(b) Ferrous Metal: Provide the following finish systems over ferrous metal:

(i) Epoxy coating System:

1) Top coat: Epoxy coating based on polyamide cured epoxy resin to produce a durable coating that has excellent chemical and solvent resistance, very good abrasion resistance.

2) Primer and intermediate coatings shall be the manufacture written recommendations

(c) Wood Works

(i) Clear Varnish: Moisture curing, single component, polyurethane – based, clear colored as directed by the Engineer varnish with gloss or matt finish to the selection of the Engineer.

(ii) Stained Woodwork:

1) Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

2) Stain Coats: High quality wood stain based on a special Penetrating Alkyd oil to penetrates deep into the wood and ensures effective and lasting protection

3) Finish Coats: Urethane modified alkyd resin, clear, fast drying and gives an exclusive durable finish.
4. DECORATIVE PAPERS AND FABRICS

4.2 MATERIALS

4.2.1 Product Requirements

*Add the following Clauses*

2 Wall-Covering Standard: Provide mildew-resistant, high quality printed photo with pictures as indicated on Drawings.

3 Size: As indicated on Drawings.

4 Colours, Textures, and Patterns: As indicated on Drawings.

4.2.2 Adhesives

*Add the following Clauses*

2 Adhesives for Printed Photo shall be of a type recommended by the manufacturer of the material to be fixed, and in the absence of such recommendation, to be to the approval of the Engineer.

3 Adhesive Type: Pressure-sensitive

(a) Application Method: Dry only

(b) Warranty: 12 years

4.3 PREPARATION OF NEW SURFACES FOR PAPERS AND FABRICS

4.3.1 Execution and Workmanship

*Add the following Clause*

6 As per manufacture Data Sheet

END OF PART
SECTION 27

EXTERNAL WORKS
2. BLOCK PAVED AREAS

The Contractor should comply with the requirements and specifications of section 27 for External Works.

2.3.2 Pine bark Mulch

1 Dimension: As indicated on drawing.

2.6 INSTALLATION OF PAVING BLOCKS

2.6.1 General Requirements

Add Clauses 9, 10, 11, 12, 13 And 14 As Follows:

9 Each block shall be placed firmly against its neighbour so that they fit closely together.

10 Joints between blocks shall not exceed 3 mm.

11 Laying of the paving blocks shall commence at right angles to the main pavement axis starting at one end of the area.

12 The blocks shall be laid in patterns as shown in the Project Documentation or instructed by the Engineer.

13 Where blocks do not fit the edge restraints or other obstructions such as manholes or upstands, the gaps shall be filled using cut blocks.

14 Blocks shall be cut using only a mechanical or hydraulic block splitter.

Add new clause 2.7 as follows:

2.7 LOOSE STONE / GRAVEL

1 Shall be obtained from river bed colored rounded cobbles.

2 Size: 50-70 mm.

3 Color: As shown in the Project Documentation or instructed by the Engineer.

4 Gravel to be placed to a minimum depth of 200 mm

5 shall be laid on Non geotextile filter fabric sheet with the following specifications:

<table>
<thead>
<tr>
<th>Product</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flyer</td>
<td>Nonwoven Geotextile Flyer</td>
</tr>
<tr>
<td>Spec Sheet</td>
<td>8 oz. Spec Sheet</td>
</tr>
<tr>
<td>Installation</td>
<td>Installation</td>
</tr>
<tr>
<td>Property</td>
<td>Test Method</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Weight (typical)</td>
<td>ASTM D5261</td>
</tr>
<tr>
<td>Grab Tensile</td>
<td>ASTM D4632</td>
</tr>
<tr>
<td>Grab Elongation</td>
<td>ASTM D632</td>
</tr>
<tr>
<td>Trapezoid Tear Strength</td>
<td>ASTM D4533</td>
</tr>
<tr>
<td>CBR Puncture Resistance</td>
<td>ASTM D6241</td>
</tr>
<tr>
<td>Permittivity*</td>
<td>ASTM D4491</td>
</tr>
<tr>
<td>Water Flow*</td>
<td>ASTM D4491</td>
</tr>
<tr>
<td>A.O.S*</td>
<td>ASTM D4751</td>
</tr>
<tr>
<td>UV Resistance</td>
<td>ASTM D4355</td>
</tr>
</tbody>
</table>
5. SITE FURNITURE

Paragraph 5.2.1 replace by the following:

5.2.1 Manufactured Units

(a) Trash bins
(b) Bicycle rack
(c) Bollard
(d) Tree grate

Add new item as follows:

3. Outdoor Furniture Schedule

(a) Bin:
   (i) Steel Structure, Metal Plate and covered with wooden lamellas
   (ii) Dimension: As Indicated on Drawings
(b) Bicycle rack:
   (i) Aluminum as per received Details Pangard II (R) as per received Details
(c) Bollard:
   (i) Bollard is made from polyester powder coated cast aluminum
   (ii) Ground fixing is either by concreting the galvanized steel tube insert into the ground or with bolts (not included) through the alternative insert with base plate Ø 150 mm.
   (iii) Maximum dimensions: H 855mm as per received Details
(d) Removable Bollard
   (i) Sitting 1000mm high above ground, is made from Ø 102mm tubular steel.
   (ii) Ground fixing is through a Ø 170mm base plate pre-drilled for ground fixing with M8 bolts (not included) or with a collar with extensions to concrete 220mm deep directly into the ground.
   (iii) The bollard is satin polished stainless steel as per received detail
   (iv) A removable version is also available supplied with a Ø 114mm steel tube insert (to concrete-in at ground level) with suitable laser-cut flat plate to insert and lock the bollard.
   (v) The tubular key hook lock fastening
   (vi) This safety system has been designed in such a way that, once the bike rack has been removed, no open holes in the pavement remain which would cause potential dangers.
   (vii) Yellow Reflective Tape: as per manufacture full range
(e) Tree grate:

(i) made from 4 or 6mm thick cast Aluminum painted with black forge oxiron as per received Details (depending on the dimensions).

(ii) laser cut and perforated with flora motifs

(iii) The grilles are made up of two halves, reinforced by a surround in 4mm thick steel plate, and designed to be screwed together.

(iv) Diminsion: 40x30x4mm, galvanised, L-profile, steel frame with brackets for installation into concrete foundations.

(v) The grilles are hot zinced (in accordance with relevant UNI standards) and polyester powder coated

(f) Seat Wall/Raised Planter Wall: details are shown on drawings and document.
7. PROTECTIVE OR SHADE COVER SYSTEMS

7.1 GENERAL

7.1.1 Summary

This Section includes polyester fabric tensioned to steel posts to comply with details on Drawings.

7.1.2 Scope of Work

1. The Fabric Structure Sub-Contractor shall be responsible for the design, engineering, fabrication, supply and installation of the fabric roofs, and all components where fabric structures are indicated including cables, concrete foundations, and any other components, complete as shown on the Drawings, as specified herein.

7.1.3 Design

1. The structural design shall comply with applicable codes and regulations.
2. Design engineering documentation of complete tensioned membrane structure will meet all applicable codes.

7.1.4 Submittals

1. Fabric Structure Sub-Contractor: Submit the name of the proposed fabric structure sub-contractor with reference of work of a similar nature carried out by him on other projects, with relevant dates.
2. Product Data: Submit manufacturer’s specifications and installation instructions. Include test reports and other data to show compliance with specifications.
3. For concrete works, structural steel and steel cables.
4. For the fabric, submit manufacturer’s specifications and test reports to show compliance with the specifications for:

7.2 PRODUCTS

7.2.1 Structural Steel

1. Structural steel shall be fabricated from structural steel using standard shapes. The steel shall be minimum ASTM A36 for standard profiles and A500 Grade B for structural tubes.
2. The fabrication of the steel shall be in accordance with guidelines set forth in the AISC steel design manual and the AWS code of structural welding. All welds shall be in accordance with manufacturers design and performed prior to shipping. No welding shall be performed in the field.
3. The structural members shall be fabricated in as large segments as possible to minimize field joints.
4. Grind all corners and sharp edges.
7.2.2 Structural Steel Cables

1 Galvanized Cables and Fittings:

(a) All structural wire rope shall be made from Wire Rope conforming to AISI Steel Cable Manual requirements with a Class A galvanized coating or approved substitute. All cable terminations and connectors shall be hot-dipped galvanized for corrosion protection. Cables should be designed with a minimum safety factor of 2 on breaking strength.

(b) Cables which are designated to be prestretched shall be prestretched per ASTM A603 for wire rope. Cables of the same type shall have the same modulus of elasticity.

(c) Sheltered end fittings shall be hot dipped galvanized.

(d) Attach a tag indicating the cable length and mark number to each cable assembly.

(e) The design load is the load in the cable under prestressed load condition.

(f) Cables shall be tensioned to double the design load before length is cut.

(g) Cables shall be tensioned to the design load when measuring the cut length that is indicated on the shop drawings.

7.2.3 Bolts and Related Fasteners

1 Fasteners and hardware accessories shall be of types and sizes best suited for the purpose.

2 Fasteners used on main structural members shall be hot-dipped galvanized high strength bolts including nuts and washers, and conforming to ASTM A325 or A490 as applicable. All other fasteners shall be adequately sized and treated for corrosion protection.

3 Unless otherwise specified on the drawings, all other bolts and nuts shall conform to ASTM A307-76B, zinc plated to conform to ASTM B633 Class Fe/Zn 8 type III.

7.2.4 Fabric

1 The fabric membrane shall be PVC (Polyvinyl Chloride), the fabric shall meet the following criteria:

(a) Construction: PVC/PVDF coated Polyester.

(b) Thickness of Coating at the Top of the Yarns: 350 micron, minimum.

(c) Total Thickness: 0.78 mm, minimum.

(d) White Index: 82%.

(e) Weight: 1050 g/m².

(f) Solar Transmission: TS 6 %.

(g) Colour: As selected by Engineer.

(h) Flame Retardant: NFPA 701

(i) Tear Strength: According to ASTM D 4595-86

   (i) Warp: 55 daN
(ii) Weft: 50 daN
(j) Tensile Strength: According to ASTM D 4595-86
   (i) Warp: 420 daN/5cm
   (ii) Weft: 400 daN/5cm
(k) UV Transmission: T-UV 0%
(l) Seams: Welded, with sufficient strength to develop 90 percent of full strength of fabric

7.2.5 Accessories

1 EPDM gasketing and flashing shall be non-reinforced, homogenous, free from defects, clean of foreign matter, and shall be manufactured to meet the following requirements:

2 Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

7.2.6 Fabrication

1 All fabric will be visually inspected for coating flaws, bow or angular distortion of the warp or fill yarns before marking out proceeds.

2 Contractor shall ensure compatibility of fabric to steelwork connections and the fitting together of shackles, pins, bolts and other components.

3 Cutting patterns shall be derived from a computer model and shall allow for the biaxial correction factors of the fabric. Fabric panels will be marked out along and at right angles to the centre line of the roll to an accuracy of 1mm.

4 If the panel is laid out on the floor prior to marking there will be no diagonal distortion of the weave. The fabric will be cut along the marked line to an accuracy of + 1mm.

5 Fabricated panels shall be free of patches and non-designed warp splices or random warp splices.

6 Folds in the panels shall be well padded to reduce crease fold damage. Completed units shall be either crated and skid mounted, or rolled on pipes. In either case, adequate over packaging is required to prevent damage during shipping.

7.2.7 Steel Finishes

1 Preparation for shop priming: prepare uncoated ferrous-metal surfaces to comply with requirements specified in Section “Painting”.

2 Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finished and those to be embedded in concrete or masonry, unless otherwise indicated.

3 Field-Applied Finishes: Two coats of polyurethane over epoxy prime and intermediate coat. Comply with requirements of Section "Painting".
4 Color: As selected by Engineer.

7.3 EXECUTION

7.3.1 Examination

1 Examine the conditions under which this work is to be performed and correct unsatisfactory conditions.

2 Correct unsatisfactory conditions before proceeding with installation

7.3.2 Erection

1 Manufacturer will prepare a full and comprehensive assembly procedure guide prior to installation.

2 Comply with the manufacturer recommendations, the approved shop drawings and the applicable Code requirements.

3 Framing and structural members: Anchor bolts shall be accurately set. Uniform bearing under base plates shall be provided using non shrink grouting compound where applicable. Members shall be accurately set to assure proper fitting and covering. As erection progresses, the work shall be securely fastened to resist the dead load and wind and erection stresses. Erected structural frame work shall be adequately guyed and secured to resist all possible loads due to wind and the installation process.

4 Fabric: Prior to start of installation; check all surfaces of framing members and other rigid construction elements to be in contact with fabric to ensure that all edges are smooth and well rounded. Remove any potential causes for snagging or tearing of the fabric. Properly install all connections and provide all materials and equipment required for the erection and stressing of the fabric. Unroll the fabric in such a manner as to avoid snagging or dragging the fabric over sharp objects during installation. Adequate fabric prestress shall be confirmed by the fabric structure manufacturer and the appearance of the fabric membrane roof shall be smooth and wrinkle free. Creasing or folding the fabric around sharp corners shall be avoided at all times.

5 Fabric tensioning system: Cables shall be free of all kinks and bends. Care shall be taken not to damage cables during installation.

6 After installation, restore marred or abraded surfaces to original condition using same paint or coating as factory-applied finishes.

7 Check structure suitability for receiving membrane before commencing fixing. Do not fix membrane until final coats of paint have been applied to outer surface of supporting structure.

8 Contractor is responsible for the safety of the structure and personnel during the installation. No advice, guidance.
8. GARDEN EDGE KERB

8.1 GENERAL

8.1.1 Related Documents

1 Drawings and General Provision of the Contract, including General Conditions, Conditions of Particular Application, and Division-1 Specification Sections, apply to work of this section.

8.1.2 Summary

1 This section covers the precast concrete curbs.

2 Related Sections include the following:

(a) Division 31 Section "Earthwork" for subgrade preparation, grading, and sub-base course.

8.1.3 Submittals

1 Materials specifications and manufacturer’s data sheet

2 Representative samples of all materials to be used in the work in full size units of each type.

3 Shop drawings showing patterns, colors and full range of variations expected

8.1.4 Quality Assurance

1 Reference Standards: Works shall be performed in strict accordance with the stipulations of the American Society of testing and materials (ASTM) and the American Association of State Highway and Transportation Officials (AASHTO).

AASHTO No.

M 33 Specifications for Joint filler

ASTM No.

C33 Concrete Aggregates

C39 Compressed strengths of cylindrical concrete specimens.

C150 Portland cement

8.1.5 Delivery, Storage And Handling

1 Store Road Curbs in a clean, dry and protected location.

2 Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
8.2 PRODUCTS

8.2.1 Materials, General

1 Materials for concrete shall be in accordance with Division 3 Section “Concrete and Reinforced Concrete”.

2 Materials for mortar shall be ordinary Portland cement to ASTM C150 and aggregates to ASTM C 33.

8.2.2 Precast Concrete Curbs

1 The curbs shall not present defects such as cracks, distortion or stripping with the dimensions, section size, length and shape shown on the drawings with fair and smooth finishing.

2 Compressive strength of concrete after 28 days shall not be less than 210 kg/cm².

8.2.3 Mortar And Grout Mixtures

1 Provide natural color Portland cement in combination with sand and filler materials to produce joints. Mortar and Grouting shall be 400 kg cement to 1 m³ sand.

2 Grading of aggregates shall be as follows:

   (a) For joints narrower than 6 mm use aggregate graded with 100% passing the No. 8 sieve and 95% the No. 16 sieve.

   (b) For pointing mortar use aggregate graded with 100% passing the No.16 sieve.

8.2.4 Mortar Mixing And Pointing

1 Combine and thoroughly mix the cementations materials, water and aggregates in a mechanical batch mixer as applicable for mixing time and water content.

2 The thickness of the joint between two (2) units of curbs shall be fixed to 5 mm in no case it shall exceed 10 mm. The joints shall be flat and smoothed with the trowel.

8.3 EXECUTION

8.3.1 Examination

1 Examine exposed subgrades and sub base surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

8.3.2 Preparation Of Ground Surface

1 Soil shall be manually or mechanically compacted uniformly to the sufficient density (95% relative density).

2 Following, an appropriate sand base in thickness indicated shall be spread and compacted to 95% relative density by tamping with plate vibrator and screed to
depth required to allow setting of pavers units.

8.3.3 Laying Precast Curbs

1 Curbs shall be bed in plain concrete layer. Joint with mortar as specified herein before as the work proceeds neatly flush pointed. Lay curbs to lines shown on Drawings with top surface flush and level. Form curves with straight pieces with angling the joints.

2 Tolerances: The finished work shall be true to line grade and levels within 5 mm and shall present a smooth appearance free from kinks and distortions visible to the eye.

8.3.4 Cleaning

1 After grouting has sufficiently set or hardened, curb surface shall be cleaned and traces of cement or dust accumulations and foreign matter shall be completely removed.

2 Repair or remove and replace curbs which may damaged during paving works on the contractor responsibilities.
SECTION 28
LANDSCAPING
1.1 General Requirements

1.1.2 References

Add the following text to item 1:

“Grade and Standards for Nursery Trees –Part II: Palms and Trees”, by Department of Agriculture, Florida, U.S.A

BS 3998 Tree Work
BS 4043 Transplanting Trees
BS 3882 Topsoil BS 3936-part I Nursery Stock and Shrubs
BS 4428 General Landscape Operations
BS 5236 Cultivation and Planting of Trees in the Extra Large Nursery Stock Category

ANSI: Z60-1 American Standard for Nursery Stock “Standard Plant Names (AJCHN), Latest Edition” by The American Joint Committee on Horticultural Nomenclature

ASTM: C 136-81 Standard Methods of Sieve and Screen Analysis of Fine and Coarse Aggregates
ASTM: D422-63 Standard Methods of Particle Size Analysis of soil
ASTM: D2607-69 Standard Classification of Peat, Mosses Humus, and Related Products,
ASTM: D2976-71 Standard Method of Test for pH of Peat Materials
ASTM: D2977-71 Standard Method of Test for Particle Size Range of Peat Materials


1.1.3 Quality Assurance

Add new item 5 as follows:

5 All items within this Section are to be designed, manufactured, and installed with safety of the public as a priority.
1.2 SHIPING, DELIVERY, STORAGE AND HANDLING

1.2.1 Shipping and Delivery

_Add new items 5 - 9 as follows:_

5. Immediately prior to transporting, plants are to be inspected, dug, handled, prepared, and packed with care in the best horticultural professional workmanship manner.

6. During transportation, plants are to be packed adequately to ensure protection from sun, wind, climatic or seasonal injuries; tarpaulins and other covers are to be placed over plants when transported by trucks or in open freight cars for more than 5 km.

7. Root systems are not to be allowed to dry out at any time and are not to be exposed to excessive heat or freezing temperatures.

8. Immediately after digging and prior to packing in moss or other suitable materials, roots are to be dipped in a solution of humectant.

9. Earth balls are to be firm and intact and contained in hessian or palm bark; plants with cracked or broken root balls will be rejected.

1.2.3 Handling

_Add new items 3 - 5 as follows:_

3. Handle balled and hessian covered plants and container grown plants by the ball or container and not by the plant stem.

4. Carefully tie head of each tree to prevent fracture of branches.

5. If soil or habit of root growth is such that finer roots are not adequately protected, wrap exposed root system in hessian or other suitable material and prevent from drying out.

_Additional Clause_

_Add new Clause 1.2.4 as follows:_

1.2.4 Transporting Palms

1. Palms shall be shipped by covered truck. Such transportation shall not exceed 24 hours from time of loading until arrival at the project site. The palms shall be transported and handled in the following manner.

2. When the palms are to be shipped, gently place the palm horizontal on a level surface and tighten the wrapping and tying of fronds. At least two layers of burlap must be used.
3  Wrap the root-ball with a minimum of two layers of burlap. Saturate with water and cover. Periodically, the burlap must be watered. Do not allow the burlap to dry out at any time.

4  Do not damage the growth bud in any manner.

5  Do not water the trunk of the palm.

6  Do not permit the root ball to become dry.

7  Use only sharp tools in cutting and trimming.

8  A bed of 150mm of moist organic amendment shall be placed on the floor of the truck. The palms shall be hoisted by means of the nylon or canvas slings and placed horizontally on the bed of the truck. They shall be nested carefully in an alternating fashion. Moist burlap shall be placed over the roots to keep them moist.

9  The entire load shall be covered snugly with two layers of tarpaulin.

10 The palms shall be secured in such a manner so as to prevent wind from lifting the tarpaulin and drying the palms.

11 The palms shall be unloaded using nylon or canvas slings.

12 Before planting at the project site trim the roots with a sharp knife in a manner to prevent mashing. The remaining root should be approximately 150mm long of living tissue.

13 Care shall be taken that the root ball is planted intact and the terminal bud is undamaged. Damaged palms shall be replaced at the contractor’s expense.

14 Palms shall be irrigated and basins shall be prepared to retain the water, the contractor shall provide sub-soil drainage to the palm growing area in case the palm pits do not drain properly.

Additional Clause

Add new Clause 1.2.5 as follows:

1.2.5  Plants Replacement

1  Contractor will be required to replace, at his own expense, planting material that does not grow and fails to survive while in the site nursery or holding area. All plants that show signs of failure to grow at any time, as determined by the Engineer, shall be removed and replaced. The Engineer will inspect the nursery growing grounds once a week or at longer intervals, at its discretion and will mark or indicate the plants to be replaced. Any plant requiring replacement shall be replaced with a plant of equal size and age as the plant found unsuitable would have been at the date of replacement. The Contractor at his own expense
shall perform removal, transporting and installing or the plants.

1.3 PRODUCTS

1.3.1 General

**Add new items 4 - 6 as follows:**

4 Plants generally are to comply with BS 3936: Part 1: 1980 and Part 10: 1981, free from pests and diseases, representative of their species or variety, of size not less than specified or shown on the drawings, with well-branched head and vigorous root system, free from injury and obtained from a nursery or other approved source.

5 If specified plants are unobtainable, submit evidence of non-availability to the Engineer, together with proposals for use of equivalent plants. Obtain approval before making any substitution.

6 Nomenclature of trees and plants shown on the drawings conform to scientific names given in the “Standardized Plant Names” of the:
   
   (a) American Joint Committee on Horticultural Nomenclature (AJCHN)
   
   (b) Royal Horticultural Society – “Directory of Gardening”
   
   (c) Post, George E., “Flora of Syria, Palestine and Sinai”, American University of Beirut.

1.3.2 Plants

**Add additional text to item 5 as follows:**

Groundcover and succulent plants are to be provided in pots or other containers. Plants acclimatized to outside conditions are acceptable provided they are equal in quantity to field grown stock and are not root bound. Ground cover plants shall be of the species, sizes, and spacing shown on the plant materials schedule, sufficient to cover fully the designated areas shown on the drawings.

**Add additional text to item 6 as follows:**

Trees are to have straight trunks or trunks characteristic of species, well-shaped tops, and intact leaders and are to be undercut at least once in the nursery. All trees are to be supplied earth balled and hessian covered or container grown. Trees shall be of the quantities, species, and sizes as shown in the plant materials schedule in the drawings.

**Add additional text to item 7 as follows:**

Shrubs are to be well grown and filled out. Deciduous shrubs may be supplied bare rooted, earth balled and hessian covered, or container grown. Evergreen shrubs and vines are to be either earth balled and hessian covered or container grown. Shrubs shall be of the quantities, species, and sizes as shown on the plant materials schedule in the drawings.
Add additional text to item 8 as follows:
Date palms to be minimum 3m clear trunk female type from approved local nursery.
Palms of 3 m height shall have a root-ball diameter of 1.30 m to 1.50m

1.3.4 Workmanship / Qualifications

Add new items 4 as follows:

4  Provide sample load of topsoil of not less than 5 m3 together with approved independent laboratory analysis and certificate of suitability. Retain sample on site for comparison with subsequent loads.

1.3.7 Spreading and Preparation of Topsoil

Add new items 5 as follows:

5  Unsuitable Topsoil: any topsoil, which is imperfect or insufficiently clean or which contains large stones, rubbish, etc. shall be removed from site and replaced with new topsoil

1.3.21 Mulch

Replace item 3 with the following sentence as follows:
Organic mulch material shall be pine bark mulch, cocobean shell, shredded bark or other suitable material approved by the Engineer.

1.3.22 Guys and Stakes

Add new items 8 - 15 as follows:

8  Provide guying materials when installation of palms does not permit sufficient depth of installation to ensure maintenance of trunk in a plumb condition throughout the warranty period.

9  Palms shall be able to stand upright without support. Guy palms which are not in accordance with this requirement. Palms shall remain plumb and straight for all conditions from installation through the warranty period.

10 Guy palms at a point 1/3 of the way down from bottom of the crown bud to finish grade.

11 Fabricate palm guying collar from 6Kmm by 50Kmm galvanized iron, either drilled to accept bolt-type guying anchors or with guying anchors welded to collar.

12 Locate palm guys in 3 equidistant locations around outside of collar. Provide three 1 by 19 air cord guys per palm with a turnbuckle for each guy. Use 2 cable clamps at each cable connection.

13 Guy bottom end of cable to deadmen buried in sub soil in 3 equidistant locations around outside of palm planting hole, as per manufacturer’s instructions.
14 Deadmen: Locust, catalpa, cedar or redwood, with one 19 mm by 100 mm galvanized steel eyebolt centered and secured on its side, screw-type galvanized steel ground anchor, or universal ground anchors, as manufactured by Laconia Malleable Iron Company, Laconia, NH, or approved equal.

15 Hardware:

(a) Guying Cable: 1 x 19 air cord, size as specified.
(b) Turnbuckles: Galvanized or dip-painted and weld less.
(c) Cable Clamps: Galvanized or copper, size as required.
(d) Plastic Guy Covers: 9Kmm diameter by 0.9 m long white plastic tubing.
(e) Trunk Collar: 6Kmm by 50Kmm galvanized iron, to fit each trunk snugly.
(f) Eye Bolts: Size as indicated on the Drawings.

1.5 PLANTING

1.5.1 Plant Pits

Add additional text to item 6 as follows:

Ensure planting areas and tree pits are well drained. In a case of poor drainage percolation test shall be conducted and drained holes augured if required.

Add new items 7 as follows:

Co-ordinate with irrigation supply system. Installations are to be tested and in working condition prior to commencing planting. Do not install planting works on other works such as irrigation supply lines, subsoil drains and other utilities, which would require inspection and approvals until such inspections have been made.

1.5.3 Installation for Trees and Shrubs

Delete Item 7 Amend first sentence in Item 8 as follows:

8 Trees 1.2 – 2.5 m tall shall be held in place with two (2) bracing stakes placed on opposite sides. (Retain remainder of paragraph)

Add new item 10 as follows:

10 Planting Sequence:

(a) Backfill pit/bed, after having tested for drainage with approved planting medium in layers not exceeding 300mm and water compact. Allow for compaction/subsidence by overfilling by 100mm.
(b) Saturate planting bays with irrigation water to the field capacity 48 hours prior to fixing planting material. Do not irrigate a day before planting procedure.
(c) During backfilling place slow release fertilizer tablets 25-30cm deep for trees. The tablets should be located approximately 1.0m from trunk or adjacent to drip emitters.
(d) Prior to planting tree stake shall be driven into tree pits.

(e) take the plants root ball. The planting hole shall be thoroughly watered prior to planting.

(f) Dip in or thoroughly spray with anti-desiccant before delivery to site. Apply again soon after planting. Do not apply in rainy weather. Ensure full coverage of underside of foliage.

(g) Plants shall be carefully removed from containers, plastic pots shall be with a knife and plants removed with all the soil intact around the roots, care shall be taken not to damage the roots or foliage of the plants.

(h) Cut back broken or damage roots to sound growth, treat cut ends over 25mm diameter with tree wound dressing.

(i) The plant shall be placed upright in the hole; care shall be taken to ensure that the collar line (line of contact between soil and stem) is at the same level as the surrounding ground.

(j) Place planting medium in pit in 150-250mm. Layers, ensure close contact with roots and eliminate air pocket, firm the planting medium as back filling proceeds taking care not to damage root, heel in firmly around root collar.

(k) For semi-mature trees: wrap trunk and lower branches with hessian strips, straw ropes or treated kraft crepe paper.

(l) Trees shall be tied to the stakes with tree ties as specified. At least two pairs of ties per tree shall be used but other ties shall be provided if necessary to keep the stem straight. If a leaser stake is required this shall be 20mm. round softwood stake slotted inside the trees tie loops.

(m) A circular watering basin slightly larger than the planting hole shall be formed. After planting the plants shall be thoroughly watering.

(n) After planting the area surrounding the plant shall be restored to finished grade and excess soils and rubbish disposed of properly.
### 1.5.9 Plant List, Spacing and Sizes

*Replace table 9 with the following table as follows:*

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
<th>Water Requirement (ltr/plant or ltr/m²)</th>
<th>Spacing (m) or Plant/m²</th>
<th>Pot size (cm)</th>
<th>Root ball dia (cm)</th>
<th>Stem girth (cm)</th>
<th>Spreading (cm)</th>
<th>Clear trunk / Total height Required size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PALMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phoenix dactylifera</td>
<td>Date Palm</td>
<td>120.0</td>
<td>As Per Design</td>
<td>60</td>
<td>125</td>
<td></td>
<td></td>
<td>2.5 m</td>
</tr>
<tr>
<td>Cycas revoluta</td>
<td>Sago Palm</td>
<td>60.0</td>
<td>As Per Design</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td>1 m</td>
</tr>
<tr>
<td><strong>TREES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azadirachta indica</td>
<td>Neem Tree</td>
<td>80.0</td>
<td>As Per Design</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td>2m</td>
</tr>
<tr>
<td>Bauhinia variegata</td>
<td>Orchid Tree</td>
<td>60.0</td>
<td>As Per Design</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td>2.5 m</td>
</tr>
<tr>
<td>Cupressus sempervirens</td>
<td>Mediterranean Cypress</td>
<td>80.0</td>
<td>As Per Design</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td>3.5 m</td>
</tr>
<tr>
<td>Delonix regia</td>
<td>Banyan Tree</td>
<td>80.0</td>
<td></td>
<td>30</td>
<td>8</td>
<td>50</td>
<td>2 m</td>
<td></td>
</tr>
<tr>
<td><strong>CONIFERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agave attenuata</td>
<td></td>
<td></td>
<td>As Per Design</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td>0.30 m</td>
</tr>
<tr>
<td><strong>SHRUBS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atriplex halimus</td>
<td>Tree Purslane</td>
<td>12.0</td>
<td>0.4</td>
<td>15</td>
<td>15</td>
<td>0.6 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jasminum sambac</td>
<td>Arabian Jasmine</td>
<td>20.0</td>
<td>0.75</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td>1 m</td>
</tr>
<tr>
<td><strong>GROUNDCOVER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iresine herbstii</td>
<td>Blood leaf</td>
<td>10.0</td>
<td>9.0</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>Ocimum basilicum</td>
<td>Sweet Basil</td>
<td>10.0</td>
<td>9.0</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>Russelia equisetiformis</td>
<td>Coral plant</td>
<td>10.0</td>
<td>9.0</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td><strong>INDOOR PLANTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dracaena braunii</td>
<td>Dragon Tree</td>
<td>10.0</td>
<td>As Per Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.15 m</td>
</tr>
</tbody>
</table>

### 1.9.1 Materials and Products

*Add new items 4 as follows:*

4 Supplier \ grower shall be a Qatar based company specializing in the production/propagation of the work of this section. Supplier \ grower \ installer shall have a minimum of 5 years' experience and be acceptable to the Project Manager.
1.11  WARRANTEE, MAINTENANCE AND HANDOVER

1.11.1  Plant establishment and Warranty period

*Add new items 3 - 9 as follows:*

3  Maintenance works upon planting material and irrigation installations shall be carried-out by the contractor for the time period of 400 days from the date of issue of completion certificate by the engineer.

4  The contractor shall maintain all materials installed and keep the site clean during maintenance.

5  The premises shall be kept neat and orderly at all times including storage areas for plant and other materials.

6  Rubbish including debris resulting from horticultural works shall be removed from the site daily as the work progresses.

7  Paved areas shall be kept clean by sweeping and/or hosing.

8  Tags, labels, nursery stakes and ties shall be removed from all plants.

9  The contractor shall separately list type of the personnel, workforce and adequate equipment to perform the maintenance works herein specified to be carried-out from the date of acceptance of the project by the engineer until completion of the 400 days plant establishment period.

1.11.2  Plant Maintenance during Establishment Period

*Add new items 7 - 31 as follows:*

7  The grass, trees, shrubs and other plants should thrive and the contractor shall carry out all normal horticultural operations to ensure this coming about.

8  The ground should appear neat, tidy and well cared for and the collection and disposal of rubbish and litter of all sorts from paths, lawns and beds shall be part of the contractor responsibilities and he shall allow for it in his rates.

9  Fallen leaves and small bark and twigs debris shall be cultivated into the soil.

10  Saucers for palms and trees shall not be dug deep, on the contrary the saucers shall be maintained as shallow as possible and surrounding ground cover or grass shall be allowed to reach the tree.

11  Remove and replace trees, shrubs, or plants found to be dead or in unhealthy condition during the defects liability period with approved, true to species equivalent trees, shrubs, or plants, unless otherwise instructed and unless defects are caused by vandalism after substantial completion. Make replacements during growing season following end of the defects liability period.

12  Provide maintenance of the planted areas from date of provisional acceptance until the end of the defects liability period and final acceptance. Make visits at weekly
intervals during the growing season and afterwards as necessary to fulfill the requirements specified in this paragraph.

13 Ensure that sufficient water is applied to maintain healthy growth of trees, shrubs, and plants. Spray crown of trees when in leaf during warm weather. Carry out watering before 5 am and in the evening until such time using schedule of watering set-up on irrigation time controller.

14 Ensure that sufficient irrigation water is applied to maintain healthy growth of trees, shrubs and plants.

Spray crown of trees when in leaf during warm weather. Carry out watering in the evening, until such time as the irrigation system is operational.

15 Maintain irrigation system and watering schedule, subject to the engineer approval to ensure proper watering of all plant material.

16 In a case of visibly poor soil drainage, perform soil percolation test in an approved commercial specialized testing laboratory in accordance with agricultural hand book no 6 of United States department of agriculture – see clause 2.10.4.

17 Prepare remedy report for the engineer approval.

18 Keep beds clear of weeds by cultivating and use of approved herbicides. Fork over beds as necessary to keep soil loose, to approved camber with no hollows.

19 Once a year, at the start of the growing season, spread approved inorganic fertilizer over all planted areas and tree pits at the rate of 50 g/m2 for planted areas and 300 g/m2 for tree pits.

20 All hedges shall be trimmed every two weeks during high vegetation period, every week in case of excessive growth of certain species. The wood shall never appear after trimming.

21 Cut back dead stems to just above healthy buds (monthly). Limit amount of pruning to minimum necessary to encourage proper growth and not to change natural habit of shape.

22 Apply tree wound dressing or fungicide on all pruned stems to avoid infection.

23 Remove burlap wrapping from palm growing buds when turgor in bud has been completely restored.

24 Check conditions of tree and palm stakes, ties, and guards. Replace broken or missing items. Adjust ties if necessary to prevent rubbing of bark. Cut back damaged bark and treat would with tree wound dressing.

25 Rake gravel to even surface and remove any litter.

26 Weeding shall consist of hand digging out all plant material other than the specified shrubs and groundcover every two weeks. Chemical weeding is strictly forbidden.
27 Pest and disease control: the contractor shall check plants material and take remedial action as appropriate and in accordance with manufacturer's recommendations. Application of fungicides or insecticides shall not be performed during the day to avoid leaf burns; application shall be done in the evening or early morning.

28 Alternate application of fungicide shall be carried out on vepe and gazu.

29 Cultivating / hoeing: cultivating shall consist of scarifying the top 80-100mm of planting bed so lumps of soil are all less than 50mm and all weeds are removed.

30 Small leaves, twigs etc. shall be cultivated into the soil, larger shall have branches removed.

31 Iron deficiency: plants prone to iron and/or trace elements deficiency shall be checked monthly and dilated iron applied as required.

1.11.3 Water Proofing for Planter Box

Water Proofing: 4 mm Thick Torch Applied Membrane (Anti Roots SBS).

Protection: 4mm Thick Polypropylene Protective Board.
Add the following new section to QCS 2014

SECTION 29
TOILET AND BATH ACCESSORIES
1. GENERAL

1.1 SCOPE

1 This Section is for the specification of toilet and bath accessories including unit mirrors and warm-air hand dryers, together with associated fixings and accessories.

1.2 SUBMITTALS

1 PRODUCT DATA: submit manufacturer's product data. Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.

2 SAMPLES: submit full-size samples for each accessory item specified for the purpose of verifying design, operation, and finish requirements. Approved samples will be returned and may be used in the work.

3 SETTING DRAWINGS: submit drawings for cut-outs required in other work; include templates, substrate preparation instructions, and directions for preparing cut-outs and installing anchoring devices.

4 PRODUCT SCHEDULE: submit product schedule indicating types, quantities, sizes, and installation locations by room of each accessory required. In the Product Schedule, use designations indicated in the Toilet and Bath Accessory Schedule and room designations as indicated on Drawings.

5 MAINTENANCE DATA: submit maintenance data for accessories, to be included in the operation and maintenance manuals specified in Section 1. Provide lists of replacement parts and service recommendations.

1.3 QUALITY ASSURANCE

1 SOURCE LIMITATIONS: unless otherwise specified or approved by the Engineer, provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas.

2 PRODUCT OPTIONS: accessory requirements, including those for aesthetic effects, materials, finishes, dimensions, capacities and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule. Products of other manufacturers with equal characteristics, as judged solely by Engineer, may be provided subject to approval do not modify aesthetic effects, as judged solely by Engineer, except with Engineer's approval. Where modifications are proposed, submit comprehensive explanatory and comparative data to Engineer for review.
2. MATERIALS AND PRODUCTS

2.1 COMPONENTS

1. STAINLESS STEEL: ASTM A 666 Type 304 unless Type 316 is indicated and required, with satin finish, in 0.8-mm minimum nominal thickness, unless otherwise indicated.

2. Steel Sheet: ASTM A 1008M, Designation CS (cold rolled, commercial steel), 0.9-mm minimum nominal thickness.


4. CHROMIUM PLATING: ASTM B 456, Service Condition SC 2 (moderate service), nickel plus chromium electro-deposited on base metal.

5. MIRROR GLASS: as per the requirements of Section 25 of the Specification.


7. FASTENERS, screws, bolts, and other devices are to be of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.2 FABRICATION

1. GENERAL: one, maximum 38-mm-diameter, unobtrusive stamped manufacturer logo, as approved by Engineer, is permitted on exposed face of accessories. On interior surface not exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

2. SURFACE-MOUNTED TOILET ACCESSORIES: unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.

3. RECESSED TOILET ACCESSORIES: unless otherwise indicated, fabricate units of all-welded construction, without mitred corners. Hang doors and access panels with full-length, stainless steel hinge. Provide anchorage that is fully concealed when unit is closed.

4. FRAMED GLASS-MIRROR UNITS: fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation. Provide galvanized steel backing sheet, not less than 0.85 mm and full mirror size, with non-absorptive filler material. Corrugated cardboard is not an acceptable filler material.

5. KEYS: provide universal keys for internal access to accessories for servicing and re-supplying. Provide and deliver a minimum of six keys to Engineer.
3. WORKMANSHIP

3.1 GENERALLY

1 COORDINATION: ensure manufacturer’s standard details and fixing instructions are provided as necessary for co-ordination with related building elements and services.

2 General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

3.2 INSTALLATION

1 INSTALL ACCESSORIES according to manufacturers’ written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

2 SECURE MIRRORS to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer’s written instructions for substrate indicated.

3 INSTALL GRAB BARS to withstand a downward load of at least 1112 N, when tested according to method in ASTM F 446.

3.3 ADJUSTING AND CLEANING

1 ADJUST ACCESSORIES for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.

2 REMOVE temporary labels and protective coatings.

3 CLEAN and polish exposed surfaces according to manufacturer’s written recommendations.

3.4 TOILET AND BATH ACCESSORY SCHEDULE

1 Refer to ID - Fixed Decoration Hardware Manual (Sanitary accessories specifications datasheets).
Add the following new section to QCS 2014

SECTION 30

LOOSE FURNITURE
1. GENERAL

1.1 Scope

1. Scope: this Section is for the specification of furniture provided loose within building spaces, together with all associated hardware, fixings, ironmongery and accessories as listed in FF&E schedule, including but not limited to:

1.2 RELATED DOCUMENTS

1. Related Sections

(a) S17 “Metal Work”
(b) S18 “Carpentry, Joinery And Ironmongery”
(c) S25 “Glass And Glazing”.

1.3 SUBMITTALS

1. Product Data for each type of furniture item specified, including material descriptions, dimensions of individual components, profiles, finishes, and accessories.

2. Samples for initial selection in the form of manufacturer’s color charts consisting of actual units or sections of units showing the full range of colors, textures, and patterns available for each type of unit indicated.

3. Samples for verification of each type of exposed finish required, prepared on samples of size approved by Engineer and of same thickness and material indicated for final unit of work. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

4. Shop Drawings: show design, dimensions and construction. Include material thicknesses, finishes, direction of wood grain for wood items, reinforcements, and attachments.

5. Control Samples: following approval of drawings and samples, prepare one of each type of purpose-made furniture as part of the quantity required for the project and obtain approval of appearance before proceeding with manufacture of remaining quantity.

6. Product Schedule: use room designations indicated on Drawings in preparing schedule.

7. Operation and Maintenance Data: for furniture items to include in operation and maintenance manuals specified. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.

1.4 QUALITY ASSURANCE

1 Manufacturer Qualifications: shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
1.5 COORDINATION

1. Coordinate layout and installation of furniture with work of other contracts.

1.6 WARRANTY

1. Special Warranty: manufacturer's standard form in which manufacturer agrees to repair or replace custom furniture that fails in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
   
   (a) structural failures, including excessive deflection, that impair furniture's usefulness
   
   (b) faulty operation of hardware
   
   (c) deterioration of finishes and other materials beyond normal wear.

2. Warranty Period: five years from date of issue of the Defects Liability Certificate.
2. MATERIALS AND PRODUCTS

2.1 FURNITURE ITEMS: ITEMS AS LISTED IN FF&E SCHEDULE.

2.2 SOURCE QUALITY CONTROL

1. Inspection And Testing: at Engineer's or Employer's option, furniture may be inspected and tested at manufacturer's expense to determine compliance with Contract Documents. Examination may be made at factory by Engineer's or Employer's representative at any time during the manufacturing process, at any point of delivery, or before installation.
3. WORKMANSHIP

3.1 INSTALLATION

1. Comply with manufacturer's printed instructions for installation.

3.2 ADJUSTING

1. Adjust components and accessories for proper operation.
Add the following new section to QCS 2014

SECTION 31

FITTINGS
1. GENERAL

1.1 SCOPE

1 This Section is for the specification of fittings (other than furniture and furnishings) fixed to the building fabric or provided loose within building spaces, together with all associated hardware, fixings, ironmongery and accessories, including:

(a) Counters, Worktops and Benches
(b) Wood kitchen cabinets
(c) Fixed Cabinets & Counter Tops at All Clinics
(d) Light Panel Framless

1.1.1 Signs:

(a) Internal Lettering and Signs

1.1.2 Sundry Fittings:

(a) Corner guard
(b) Pipe protection rail
(c) Curtain Support Systems
(d) IV Support Systems
(e) Cubicle curtain
(f) Roller window shades

1.1.3 GRP Fabrications:

(a) GRP Ladders

1.1.4 Equipment:

(a) Window Washing Equipment
(b) Loading Dock Equipment
(c) Fire Curtains
(d) Ready Made Fountain

1.1.5 Related Sections and Parts are as follows:

(e) Section 17 Metalwork
(f) Section 18 Carpentry, Joinery and Ironmongery
(g) Section 24 Finishes To Building
(h) ID Drawings and Data Sheets
1.2 SUBMITTALS

1 Product Data: submit manufacturer’s product data and specifications for each type of fitting, including construction details, material descriptions, dimensions of individual components and profiles, together with charts showing the full range of finishes and colours available, for selection by the Engineer.

2 Drawings: provide co-ordination, fabrication and installation drawings and other information showing such details of the work as the Engineer may reasonably require including elevations, large scale sections and proposed methods of fixing.

3 Samples: submit samples of each type of fitting in colours and finishes selected by the Engineer. Obtain approval of appearance and other characteristics before proceeding with manufacture or delivery.

4 Control Samples: following approval of drawings and samples, prepare one of each type of purpose-made fitting as part of the quantity required for the project and obtain approval of appearance before proceeding with manufacture of remaining quantity.

1.2.1 Submittals (Signs)

1 Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign.

2 Shop Drawings: Include plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details.

(a) Provide message list for each sign, including large-scale details of wording, lettering, artwork, and braille layout.

(b) Wiring Diagrams: For signs with illuminated characters.

(c) All graphic layouts for all signs.

3 Samples for Initial Selection: For each type of sign material indicated that involves color or finish selection.

4 Samples for Verification: For each type of sign indicated in sign type details, drawings and schedule, and for full range of color, texture and sign material, include the following Samples, but not limited to following, to verify color selected:

(a) Panel Signs: Full-size Samples of each type of sign required.

(b) Dimensional Characters: Full-size Samples of each type of dimensional character (letter and number) required. Show character style, material, finish, and method of attachment.

(c) Casting: Show representative texture, character style, spacing, finish, and method of attachment.

(d) Approved samples will not be returned for installation into Project.

5 Qualification Data: For Installer.

6 Maintenance Data: For signage cleaning and maintenance requirements to include in maintenance manuals.
7 Sample Procedures:

(a) Sample Requirements: All samples shall be submitted together. Samples shall be 254 mm x 254 mm in size of all sign materials with the required colors and finishes to show quality, type, range, texture and other specified characteristics. Samples shall be submitted from the same source, which will supply the actual job. Samples of materials or products, which are normally furnished in containers or packages, which bear descriptive labels and/or application or installation instructions, shall be submitted with such labels and/or instructions.

(b) Identification: All Samples shall be labeled, tagged, or otherwise clearly identified. Labels or tags shall set forth the name of the Project, Project Number, building Parcel number, location and other facilities for which the Sample is being submitted, Contractor, Subcontractor, and/or supplier, the name of the manufacturer, fabricator, or processor, the trade designation, grade and quality of the material of the product, the date of submittal, and specific identification of each sample and a precise reference to the Specification Section and paragraph wherein the material, product, or element of the work is specified. Each label or tag shall have sufficient clear space to permit the application of the review stamps to the Contractor and the Engineer.

(c) Mockups:
   (i) Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects.
   (ii) Build one mockup of each of the specified Sign Types

(d) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

(e) Maintenance Data: Submit manufacturer’s care and maintenance data, including care, repair and cleaning instructions. Include in Project closeout documents.

1.2.2 Quality Assurance (Signs)

1 Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.

2 Interior Code Signage: Provide signage as required by accessibility regulations and requirements of authorities having jurisdiction.

1.2.3 Project Conditions (Signs)

1 Field Measurements: Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.
2. MATERIALS AND PRODUCTS

2.1 COMPONENTS

1 Metal, wood and other component parts of fittings including fastenings, fixings, treatments and finishings are to be in accordance with the requirements of Sections 17 and 18 of the specification.

2 Marble or Granite counter tops, fronts and the like are to be in accordance with the requirements of Section 24 of the specification.

3 Glass and the like are to be in accordance with the requirements of section 25 of the specification.

2.2 COUNTERS, WORKTOPS AND BENCHES

1 Counters: constructed from wood and wood based boards, faced on all exposed surfaces as indicated, and comprising counter tops, fronts and cupboard units with doors, drawers and shelves, and with hinges, sliding gear, locks, handles, drawer slides, accessories and fixings as required, all to be approved.

2 Kitchen/ Pantry Cabinet and Counter Tops:
   (a) Kitchen Cabinets: to BS 6222, constructed of blockboard, faced on all exposed surfaces with decorative laminated plastics sheet. Fittings are to comprise carcass, doors, drawers, shelves and plinths, and with manufacturer's matching ironmongery, accessories and fixings.
   (b) Sink is to be as per Mechanical Specification
   (c) Countertop for Drop-in sink: Counter tops, fronts and the like are to be in accordance with the requirements of Section 24 of the specification and as indicated. Counter tops in toilet will be of HPL countertops will be of HPL unless indicated.

3 Fixed Cabinets & Counter Tops at All Clinics :
   (a) HPL-laminated have to be constructed with backsplashes of 40 mm at a thickness of 40 mm with eased edge.
   (b) Casework of HPL-laminated boards to be Self-contained construction, material of massive HPL-laminated plates, 20 mm thick according to EN 438 respectively DIN 16926 as well as flame resistant according to DIN 4102, leading edge rounded down (4 mm radius).
   (c) Top and bottom of the counter tops have to be covered with a layer of HPL.
   (d) Leading edge of the work tops have to be rounded down (10 mm radius).
   (e) Connection of counter tops has to be seamless and with hidden edges
   (f) Fire Rating : Group 1S
   (g) Size : As Per Design Requirements
   (h) HPL Table Top for Control Room in X-RAY Room
   (i) Sterilization Room Cabinet should be Stainless steel CSSD Worktop with stainless steel open shelves cabinets
   (j) The cabinets material in dental clinic is powder coated steel.
4 Stainless Steel Cabinet with open shelves
   (a) Thickness: As indicated on drawing
   (b) Finish: Satin

5 Solid Surface
   (a) Thickness: As indicated on drawing
   (b) Colour: as per Engineer Approval
   (c) Chemical Resistance: according to DIN 68861 & KIN 68930
   (d) Stain and chemical resistance
   (e) Physical Requirements: As per manufacture full range
   (f) Warranty: 10 years

6 Decorative laminates HPL
   (a) Panel Size: As indicated on drawing
   (b) Thickness: min 12 mm unless otherwise indicated on drawing
   (c) highly resistance surface demanded

2.3 LIGHT PANEL
   (a) Color: As Per Engineer Approval
   (b) Dimension: As Indecated on Drawings
   (c) Thickness: approx 40 mm
   (d) Material: Polymethyl methacrlat-Casted acrylic glass
   (e) Back Material: PVC Foam
   (f) Frame: Aluminum –white powder coated
   (g) Electronic componantes: LEDs in the edge
   (h) Material Properties:
      (i) Fire Classification: B2 (DIN EN 4102)
      (ii) Smoke Gas Toxicity: Non Toxic
      (iii) Tensile Strength: 40-110 MPa

2.4 ACRYLIC PANEL PARTITIONS

1 comprising stainless steel framework, acrylic infill panels and openings for glazing. System is to be supplied complete with manufacturer's standard cover strips, glazing beads, ironmongery, accessories and fixings. Components are to be as follows:

   Framework: Stainless steel section top and bottom rails either straight or uniformly curved as indicated. Finish as selected by the Engineer from manufacturer's full range catalogue. Where indicated provide Bottom rail concealed in the flooring and top rail concealed
in the ceiling to give a frameless look to the partition.

**Glazing**

Made of acrylic resin and suitable interlayer to give indicated colour, pattern and finish. Panel shall be minimum 9.5 mm and shall meet all the structural performance for the intended use. Sheet minimum performance:

(i) Rate of Burning (ASTM D 635). Material must attain CC1 Rating for a nominal thickness of 1.5 mm (0.060 in.) and greater.

(ii) Self-Ignition Temperature (ASTM D 1929). Material must have a Self-ignition temperature greater than 650°F.

(iii) Density of Smoke (ASTM D 2843). Material must have a smoke density less than 75%.

(iv) Flame spread and Smoke developed testing (ASTM E 84). Material must be able to meet a level of Class A (Flame spread less than 25 and smoke less than 450) at thickness of 1".

(v) Room Corner Burn Test (NFPA 286). Material must meet Class A criteria at ¼" thickness as described by the 2003 International Building Code.

(vi) Extent of Burning (UL 94). Must submit UL card.

(vii) Impact strength. Minimum impact strength test as measured by ASTM D 3763 of 20 ft. lbs. (for durability, shipping, installation, and use).

(viii) Safety Glazing. Material must attain a Class A impact rating in accordance with ANSI Z97.1-2004 at 1/8" thickness.

(ix) UPITT Test for Combustion Product Toxicity; Product must be recorded as “not more toxic than wood”.

(x) Dynamic environmental testing (ASTM standards D 5116 and D 6670). Panels must not have detectable VOC off-gassing agents and must be have Greenguard™ Indoor Air Quality certified.

(xi) Panels must be produced from a minimum of 40% post-industrial recycle content. This recycle content must be certified by a recognized 3rd party certification group, such as Scientific Certification Systems (SCS).

(xii) Building Approvals: Plastic Fabrications are to have been evaluated and must be registered with and comply with requirements
of the local jurisdiction(s).

Accessories As selected by the Engineer unless indicated

2 Provide sliding acrylic panel partitions with necessary fixing, fitting and hardware where indicated.

2.5 SIGNS

2.5.1 Warranty

1 General Warranty: The special warranty specified in this Article shall not deprive Employer of other rights Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

2 Special Warranty: Provide complete system warranty in which Manufacturer, Installer, and Contractor are jointly and severally responsible and agree to repair or replace signs that fail in materials, finishes or workmanship within specified warranty period. Failures include, but are not limited to, the following:

(a) Deterioration of metals, metal finishes, and other materials beyond normal weathering.

(b) Deterioration of embedded graphic image

(c) Deterioration of failure of dynamic units.

3 Warranty Period: five years from date of Substantial Completion.

2.5.2 Coordination

1 For signs supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for placement of anchorage devices and similar items to be used for attaching signs.

(a) For signs supported by or anchored to permanent construction, furnish templates for installation of anchorage devices.

2 Coordinate location of remote transformers with building construction. Ensure that transformers are accessible after completion of Work.

3 All room numbering, Arabic and English messaging must be verified, coordinated, and adjusted (if necessary) by the Fabricator, and approved by building management and all required stakeholders prior to fabrication.

4 Directory map artwork shown on all Wayfinding Signage Documents is only a placeholder mock-up with the intent of relaying general design intent. Directory map artwork must be coordinated with the designers, building management and all required stakeholders for final approval. All final directory map artwork must be designed, verified and approved prior to fabrication.

2.5.3 Panel Signs

1 General: Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction. Produce smooth panel sign surfaces constructed to remain flat
under installed conditions within tolerance of plus or minus 1.5 mm measured diagonally.

2 Aluminum sheet and Plate for single flat panels: shall be in the thickness indicated and shall be of an alloy and temper recommended by the aluminum producer or finisher for the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B209 for alloy 6061-T6.

3 Aluminum Sheet and Plate for forming and/or welding: shall be in the thickness and profiles indicated, and shall conform to ASTM B 209M, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of 5005-H16.

4 Aluminum extrusions where specified shall be of an alloy and temper recommended by the aluminum producer or finisher of the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B221 for alloy 6063-T5 unless particular extrusions are specified.

5 Stainless-Steel Sheet lettering signs and background sheet: ASTM A 240/A 240M or ASTM A 666, Grade 316 for Sheet and 616 For Cut Out

6 Engineered Polyester Resin (3Form Varia or equal):
   (a) Basis of Design Product: The design of the plastic fabrication is based on Varia produced with ecoresin as provided by 3Form, Inc. Equivalent products from other manufacturers can be acceptable.
   (b) Thickness: Minimum 1.5 mm gauge; Maximum 25.4 mm gauge
   (c) Compatible with polyesters and bonding process to create a monolithic sheet of material when complete.
   (d) Sheet minimum performance:
      (i) Rate of Burning (ASTM D 635). Material must attain CC1 Rating for a nominal thickness of 1.5 mm (0.060 in.) and greater.
      (ii) Self-Ignition Temperature (ASTM D 1929). Material must have a Self-ignition temperature greater than 650°F.
      (iii) Density of Smoke (ASTM D 2843). Material must have a smoke density less than 75%.
      (iv) Flame spread and Smoke developed testing (ASTM E 84). Material must be able to meet a level of Class A (Flame spread less than 25 and smoke less than 450) at thickness of 1”.
      (v) Room Corner Burn Test (NFPA 286). Material must meet Class A criteria at ¼” thickness as described by the 2003 International Building Code.
      (vi) Extent of Burning (UL 94). Must submit UL card.
      (vii) Impact strength. Minimum impact strength test as measured by ASTM D 3763 of 20 ft. lbs. (for durability, shipping, installation, and use).
      (viii) Safety Glazing. Material must attain a Class A impact rating in accordance with ANSI Z97.1-2004 at 1/8” thickness.
(ix) UPITT Test for Combustion Product Toxicity: Product must be recorded as “not more toxic than wood”.

(x) Dynamic environmental testing (ASTM standards D 5116 and D 6670). Panels must not have detectable VOC off-gassing agents and must be have Greenguard™ Indoor Air Quality certified.

(xi) Panels must be produced from a minimum of 40% post-industrial recycle content. This recycle content must be certified by a recognized 3rd party certification group, such as Scientific Certification Systems (SCS).

(xii) Building Approvals: Plastic Fabrications are to have been evaluated and must be registered with and comply with requirements of the local jurisdiction(s).

2.5.4 Panel Connections: Stand-Off Systems:

1 Basis of Design Product: The design of stand-off Fabrications is based on Point Support™ anchoring systems as provided by 3form, Inc. Equivalent products from other manufacturers can be acceptable.

2 Point Support stand-off and anchoring systems (or approved equal):

   (a) Standard 1 Part Cap system with threaded shaft
   (b) Cap size diameter: Maximum 25 mm (1”)
   (c) Finish: Natural (clear anodized)

3 Panel Gauge and Stand-off Pattern: The number and sizing of point supports shown are for general design intent purposes only. The final required number and sizing of point supports for a given panel is based on the final panel’s gauge thickness and mounting method/condition, and must address both deflection and weight. Submit final engineering as per the manufacturer’s required specifications for Engineer’s approval.

4 Phenolic-Backed Photopolymer Sheet: Provide light-sensitive, water-wash photopolymer face layer bonded to a phenolic base layer to produce a composite sheet with overall, face-layer, and base-layer thicknesses, respectively, of 3 mm, 1 mm, and 2 mm; and a Type D Shore durometer hardness of 80.

2.5.5 Screen Process Printing

1 All message patterns and graphics specified to be screen process printed shall be printed from photographic screens prepared from the details. Film positives shall be submitted for review, prior to preparation of screens. All screen process printing shall be executed in such a manner that all edges and corners of finished letterforms are sharp, true, and clean. Letterforms, symbols, and borders with rounded positive or negative corners edge buildup, bleeding or spattering, etc., will not be acceptable. Hand-cut screens will not be accepted.

2 Contractor shall prepare each screen in one continuous piece to accommodate total message coverage, unbroken horizontally or vertically except where such breaks are indicated on the drawings.

3 Contractors shall order or mix paint for each color in sufficient quantity to assure consistent application on all signs specified in a given color.
4 Contractor shall apply all paints evenly without pin holes, scratches, orange peeling, etc., and allow surface to air dry for forty-eight (48) hours prior to the application of a masking film to protect these sign faces during shipping and erection.

5 Contractor shall screen all messages to achieve the colors specified. Regulatory and warning signs (if utilized) shall have characters in the colors indicated.

6 Contractors shall use paint of a type made for the surface material on which it is to be applied. The paints shall be the finest quality of heat-, moisture-, and fade-proof pigments and vehicles. All colors shall be color approved by the Engineer. No ink, paint, or lacquer that will fade, discolor or delaminate as a result of proximity to UV light source shall be used. All messages and symbols shall be white on background color indicated unless otherwise specified.

2.5.6 Machine-Cut Graphics

1 All applied characters, arrows and symbols, as specified on the contract documents shall be either reflective or non-reflective vinyl – manufactured under the trade name “Scotchlite” or “Scotchcal” by the Minnesota Mining and Manufacturing Company (3M) and shall be applied in accordance with the recommendations of the manufacturer. All adhesives shall be permanent unless designated as “peel able adhesives”.

2 Copy shall be machine-cut to conform to the prescribed forms and within a tolerable of plus or minus 0.015 inches and shall be free of irregularities such as nicks, burrs, broken points and discontinuous curves, all letters, symbols and targets shall be pre-aligned and pre-spaced on carrier tapes as indicated and the letter spacing indicated and/or specified. The Sign Contractor shall not be permitted to cut apart characters, words, symbols, and message lines or in any way alter the alphabet spacing, message layouts and dimensions in the fabrication of message patterns without the approval of the Engineer.

3 Laminated Panels: Permanently laminate face panels to backing sheets of material; use manufacturer’s standard process.

4 Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory-paint brackets in color matching Engineer’s sample.

5 Graphic Content and Style: Provide sign copy that complies with requirements indicated in the Sign Schedule for size, style, spacing, content, mounting height and location, material, finishes, and colors of signage.

6 Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are nonfading for application intended.

2.5.7 Accessories

1 Vinyl Film: Provide opaque nonreflective or reflective vinyl film, 0.089-mm minimum thickness, with pressure-sensitive adhesive backing suitable for both exterior and interior applications.
2 Mounting Methods: As indicated in the sign schedule, fabricated from materials that are not corrosive to sign material and mounting surface.

3 Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

4 Note Holders: Manufacturer's standard aluminum paper sheet holders.

2.5.8 Fabrication

1 Fabricate signs to comply with requirements indicated for materials, thickness, finishes, colors, designs, shapes, sizes and details of construction as shown on the Contract Documents.

2 Insofar as practicable, fabrication, assembly and fitting of the work shall be executed in the shop with the various parts or assemblies ready for erection at the site.

3 Work that cannot be shop assembled shall be given a trial fit at the shop to assure proper and expeditious field assembly.

4 All fabricated sign joints, comers, miters, etc., shall be accurately machined, filed and fitted, and rigidly framed together at joints and contact points.

5 All work shall be carefully matched to produce a perfect continuity of lines and design. Materials in contact shall have hairline joints, unless otherwise shown on the drawings, and shall be painted smooth to give a monolithic appearance. All mechanical fasteners shall match color and finish of the sign area where they occur.

6 Concealed surfaces to be in contact with concrete or dissimilar metals shall have an applied heavy coating of bituminous paint.

7 Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within tolerances specified for the particular product.

8 All removable members shall be carefully machined and fitted and shall be secured by mechanical fasteners of proper size and approved spacing.

9 The Contractor, when applicable, shall incorporate the latest proven technological achievements in the field of sign manufacturing to achieve maximum service life and superior attractiveness of appearance.

10 Fabrication of Message Patterns – Except for signs to be screen process printed, full-scale fabrication message patterns shall be prepared by the Contractor for selected sample messages to be identified by the Engineer. Contractor shall provide full-size patterns from master alphabet and master symbols and transmit these to the Engineer for approval. Contractor shall exercise extreme care to provide the appropriate letter and word spacing, as indicated on the drawing. As a guide, all non-illuminated signs shall have normal letter and word spacing. All internally illuminated and reflective signs shall have wide letter and word spacing.
2.5.9 Engineered Polyester Resin

1 General: Fabricate ecoresin Fabrications to designs, sizes and thicknesses indicated and to comply with indicated standards. Sizes, profiles and other characteristics are indicated on the drawings.

2 Comply with manufacturer’s written recommendations for fabrication.

3 Machining: Acceptable means of machining are listed below. Ensure that material is not chipped or warped by machining operations.
   (a) Sawing: Select equipment and blades suitable for type of cut required.
   (b) Drilling: Drills specifically designed for use with plastic products.
   (c) Milling: Climb cut where possible.
   (d) Routing
   (e) Tapping

4 Forming: Form products to shapes indicated using the appropriate method. Comply with manufacturer’s written instructions.
   (a) 1st surface Laser Etched characters
   (b) Hot Bending
   (c) Adhesive Seams
      (i) Miter UV Glue Seam
      (ii) Light Seam

5 Laminating: Laminate to substrates indicated using adhesives and techniques recommended by manufacturer.

6 Miscellaneous Materials
   (a) General: Provide products of material, size, and shape required for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
   (b) Cleaner: Type recommended by manufacturer.
   (c) Fasteners:
      (i) Use screws designed specifically for plastics.
      (ii) Self-threading screws are acceptable for permanent installations.
      (iii) Provide threaded metal inserts for applications requiring frequent disassembly.
      (iv) Per manufacturer requirements, Varia ecoresin must be protected from metal contact by utilizing manufacturer recommended bushings and washers when using stand-off anchoring/fastening systems.
   (d) Bonding Cements: May be achieved with solvents or adhesives, suitable for use with product and application.
2.5.10 Miscellaneous Steel and Metals

1 General:
   (a) Sign steel frames, where indicated shall be constructed of standard structural steel shapes, tube and/or steel plates. All welds shall be full penetration welds and shall be ground smooth unless otherwise shown.
   (b) Design, detailing, fabrication and erection shall conform to the requirements of the following publications unless otherwise noted.
       (v) Tentative Recommended Practices for Providing High Quality Zinc Coatings (Hot-Dip) on Assembled Projects. ASTM Designation A 123.

2 Materials:
   (a) Structural steel shall be made from new billets of domestic manufacture conforming to ASTM Specification A-36.
   (b) Structural tubing shall be ASTM A500, Grade B (FY=46KSI).
   (c) All hardware used in supplying and connecting the various structures shall be high-strength bolts, nuts, and suitable hardened washers. Connection bolts for shop and field connections shall be stainless steel.
   (d) Bolts, nuts, and washers shall be fabricated from Stainless steel grade 304 unless otherwise indicated.
   (e) Postinstalled Anchors: Torque-controlled expansion anchors.
       (i) Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
       (ii) Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941M, Class Fe/Zn 5 unless otherwise indicated.
   (f) Anchor bolts shall be fabricated from quenched and tempered steel studs with coarse, grade 60 threads. Nuts shall be heavy hex. Washers shall be suitable hardened washers. Anchor bolts, nuts, and washers shall be stainless steel.
   (g) Mechanical fasteners shall be concealed, unless otherwise indicated and
shall be non-corrosive to either sign materials or sign structure.

(h) Bolted connection shall be made with ASTM A-325 Type F High Strength bolts with diameter as noted.

3 Methods:

(a) All work in shop and field shall be carefully laid out.
(b) Field measure in the field to assure a fit and avoid immovable obstructions.
(c) Sign structures shall be true vertical and properly aligned.

4 Fabrication:

(a) Fabrication shall be clean and true and in accordance with applicable National Codes and Specifications. All contact surfaces, whether bolted or welded, shall be checked for true plane faces and the absence of burns or other obstructions to snug fits.

2.5.11 Finishes

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.

3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

4. For exposed sign materials, which require selection of materials with integral or applied colors, surface textures or other characteristics related to appearance, provide color matches indicated.

5. All finish sheen is to be satin unless otherwise noted.

6. Clear Anodic Finish: Manufacturer's standard clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured) mechanical finish.

7. All aluminum exterior surfaces are first formed to the appropriate profile and then receive a protective coating:

(a) Polyester Powder coating for aluminium alloy components is to be approved type to meet the requirements of AAMA 2603 or BS 6496 and BS EN 13438 consisting of powder particles of resinos material and additives to improve performance. The coating is to be electrostatically sprayed on the object to produce produces a hard, durable coating:

(i) surface finish: As indicated
(ii) minimum dry film thickness: 80 microns

8. All steel exterior surfaces, except where required to be hot dip galvanized, shall be prepared and painted with a 3-coat Polyurethane primer and top coat system
as follows:

(a) Remove grease and dirt and clean metal by commercial blast cleaning.
(b) Apply one (1) coat of epoxy primer to a thickness of four (4) mils when dry.
(c) Apply two (2) finish coats of Polyurethane enamel to a thickness of two (2) mils for a finished coat of four (4) mils.
(d) Finish sheen is to be gloss.

9. Each coat of paint shall be applied as a continuous film of uniform thickness free of pores. Any thin spots or missed areas shall be repainted and permitted to dry before the following coat of paint is applied.

10. During the application of paint, care shall be taken to prevent runs and sags. Should either occur, the application shall be sanded out and re-painted.

11. After drying, any areas of paint damaged for any cause shall be removed, the surface again prepared and then repainted with the same paint and same thickness as the damaged area.

12. Engineered Polyester Resin (3form Varia ecoresin or equal):

(a) Surface Finishes:
   (i) Finish products to shapes indicated using the appropriate method listed below. Comply with manufacturer’s written instructions.
   (ii) Raised graphics & symbols: CNC Frost Cut process

(b) Edge Finishes:
   (i) Utilize an easing process to reduce all sharp and/or jagged areas on all edges of the finished product.

13. Stainless Steel Finishes:

(a) Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

(b) Directional Satin Finish: No. 4 finish.

(c) When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean

2.5.12 Installation

1. General: Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer’s written instructions.

(a) Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.

(b) Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 75 mm of sign without encountering protruding objects or standing within swing of door.
(c) Install Glass Mounted Signs using 3M Sheet adhesive tape 7952 or approved equivalent.

(d) Install Ground Mounted sign (1sign/Pylon) using approved concealed mechanical fixation.

(e) Install Blade sign, wall mounted using approved concealed mechanical fixation.

(f) Install Aluminum back panel wall mounted signs using approved concealed mechanical fixation.

(g) Install Wall Mounted Signs using 3M VHB tape or approved equivalent.

2. The Contractor shall inspect all location, surfaces, and other works previously installed by others and promptly report to the Engineer any conditions that might impair the durability or appearance of his work.

3. Contractor shall make himself familiar with the Contract Documents and shall provide all signs and graphics required as indicated. The Contractor shall thoroughly examine the Contract Documents and Specifications, carefully checking the dimensions before commencing work, and shall report any discrepancy that occurs, and shall request interpretation before proceeding with the work. Should conflict occur in or between Contract Documents and written specifications, the more stringent requirements and more expensive apply. Where special job conditions occur, or where there is uncertainty as to interpretation, before execution of the work, contractor shall inform the Engineer for clarification and information. Contractors shall make complete on-site measurements before commencing fabrication. Dimensions shall not be determined by scale or rule, and final fabrication measurements shall not be made from graphic scale layouts, which functions as guides only.

4. Deliver all signage and graphics products and materials in protective wrapping and store protected from weather, moisture and soiling.

5. All signs shall be installed as indicated by the sign details as specified in the Contract Documents. All surfaces receiving application of signs shall first be cleaned of all dirt and/or accumulated foreign matter.

6. All signs are to be cleaned after installation to remove all smears, smudges, dust, dirt or other surface obscurations. If sign had a temporary cover, cleaning will be required to remove dust and dirt from the sign surface where the cover is removed. Cover to be disposed of properly off site.

7. All painted surfaces of signs to be restored to factory shipped conditions using touch up paint or other acceptable Engineer specified process, for all areas needing touch up, or if colors are light or rubbed off due to shipping or installation. All painted surfaces of signs to be restored to factory shipped conditions using a fabricator provided touch up paint or other acceptable Engineer specified process if colors need touch up or are light or rubbed off due to shipping or installation.

8. Contractor shall assume full liability, with regard to damages and losses as a result of incorrect and/or insufficient sign fabrication and installation.

9. The Contractor shall assume the responsibility for the location of concealed post-tensioned cables in concrete before drilling for concrete anchors, with positive
detection devices.

10. Install the work plumb, level and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch in 8 feet-0 inches for plumb and level with maximum 1/32 inch offset in flush adjoining structural, free from distortion or other defects of appearance.

11. The Contractor will allow for an appropriate area for all deliveries to be assembled for inspection prior to installation. The Contractor will provide time in scheduling a job for sufficient time to allow for corrections and repairs to be completed at job site before installation if needed.

12. Installation of Engineered Polyester Resin (3Form or equal):
   
   (a) General: Comply with manufacturer’s written instructions for the installation of Plastic Fabrications.
   
   (b) Manufacturer’s shop to fabricate items to the greatest degree possible.
   
   (c) Utilize fasteners, adhesives and bonding agents recommended by manufacturer for type of installation indicated. Material that is chipped, warped, hazed or discolored as a result of installation or fabrication methods will be rejected.
   
   (d) Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
   
   (e) Form field joints using manufacturer’s recommended procedures. Locate seams in panels so that they are not directly in line with seams in substrates.

2.5.13 Sign Installation Location

1. In general, the signs shown on the Location Plans are located schematically. The Contractor shall notify the Engineer of any location changes from those indicated on the Location Plans and gain approval before sign installation.

2. The Contractor shall layout, measure, and mark each sign location by sign identification code for review and approval before proceeding with installation.

3. The Contractor shall lay out all the work and make all surveys necessary for the satisfactory completion of the work in accordance with the Contract Documents. The Contractor shall be responsible for all measurements required for the execution of the work.

4. The Contractor shall furnish, at his expense, such templates, platforms, equipment, tools, and materials, and all labor as may be required in layout of any part of the work indicated. It shall be the responsibility of the Contractor to maintain and preserve all marks established until authorized to remove them, and if such marks are destroyed by the Contractor or through his negligence, prior to their authorized removal, the Contractor shall promptly replace them. The Engineer shall require that work be suspended at any time when survey marks established by the Contractor are not reasonably adequate to permit satisfactory prosecution and control of the work.

5. The Contractor shall provide competent and experienced personnel for all layout work. All survey and layout performed by the Contractor will be subject to
verification.

2.5.14 Cleaning and Protection

1. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Employer.

2. Repair work or replace damaged work, which cannot be repaired to Engineer’s satisfaction.

2.6 SUNDRY FITTINGS

2.6.1 Pipe protection rail:

1. Pipe protection rail fabricated from 50mm galvanized steel pipe painted. Color to be as indicated on drawing.

2.6.2 Foot grille:

1. 316L grade stainless steel grid, with minimum rolling load tested to 500lbs and 5/8” depth, suitable for heavy and medium pedestrian traffic.

2. Stainless-Steel Foot Grilles:
   (a) Tread Wires: No. 4 finish.
   (b) Grating: Mat.

3. Frame: Same material and finish as foot grille.


2.6.9 Curtain Support Systems:

1. Extruded-Aluminum Curtain Track: Not less than 32 mm wide by 19 mm high unless otherwise indicated.

2. Curved Track: Factory-fabricated, 305-mm- radius bends.


4. Curtain Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.

5. Suspended-Track Support: Not less than 22.2-mm- OD tube.


7. Switch Unit: Shuttle and coupling device for rerouting and securing cubicle curtain, with pull chain for switching track.

8. Curtain Carriers: Two nylon rollers and nylon axle with aluminum hook.
9 Exposed Fasteners: Stainless steel.

10 Concealed Fasteners: Stainless steel.

11 Curtains

   (a) Cubicle Curtain Fabric: Curtain manufacturer’s standard, 100 percent polyester; inherently and permanently flame resistant, stain resistant, and antimicrobial.

   (b) Color: As selected by Engineer from manufacturer's full range

12 Curtain Fabrication

   (a) Fabricate curtains as follows:

      (i) Width: Equal to track length from which curtain is hung plus 10 percent added fullness, but not less than 305 mm added fullness.

      (b) Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor as follows:

         (i) Vertical Seams: Not less than 13 mm wide, double turned and double stitched.

2.6.10 I.V. Support Systems:

1 IV Tracks: Extruded aluminium, not less than 32 mm wide by 19 mm high; with 1.47-mm minimum wall thickness.

Curved Track: Factory-fabricated, 305-mm- radius bends.

Finish: Clear anodized.

IV Carriers: Four nylon rollers and steel axles with ball bearings and with hanger loop fabricated from 6-mm- diameter stainless steel.

2.6.12 Motor-Operated, Single-Roller Shades

1. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

2. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.


5. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
(a) Keyed Control Station: Keyed, maintained -contact, three-position, switch-operated control station with open, close, and off functions. Provide two keys per station.

(b) Individual Switch Control Station: Maintained -contact, five-position, toggle -style, wall-switch-operated control station with open, close, and centre off functions.

(c) Group Control Station: Maintained -contact, three-position, rocker-style, wall-switch-operated control station with open, close, and centre off functions for single-switch group control.

(d) Individual/Group Control Station: Maintained -contact, three-position, rocker-style, wall-switch-operated control station with open, close, and centre off functions for individual and group control.

(e) Sun Sensor Control: Adjustable system consisting of digital displays detecting sun intensity and responding by automatically adjusting shades.

(f) Infrared Control: System consisting of concealed receiver complete with external eye and connecting modular cable and two portable, multiple-channel transmitters with separate buttons to open and close up to 12 individual shades or groups of shades, to open and close shades simultaneously, and to stop shade movement.

(g) Timer Control: Clock timer, 24-hour programmable for regular events.

(h) Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features; isolated from voltage spikes and surges.

(i) Color: As selected by Architect from manufacturer's full range.

6. Crank-Operator Override: Crank and gearbox operate shades in event of power outage or motor failure.

7. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.

8. Operating Features:

   (a) Group switching with integrated switch control; single faceplate for multiple switch cutouts.

   (b) Capable of interface with audiovisual control system.

   (c) Capable of accepting input from building automation control system.

   (d) Override switch.

9. Accessories:

   (a) Solar power unit.

      (i) Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

      (ii) Roller Drive-End Location: As indicated.
(iii) Direction of Shadeband Roll: Regular, from back of roller.

(iv) Shadeband-to-Roller Attachment: Manufacturer's standard method.

(v) Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

(vi) Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.

(vii) Shadebands:
   2) Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
   3) Type: Enclosed in sealed pocket of shadeband material.
   4) Color and Finish: As selected by Architect from manufacturer's full range.

(viii) Installation Accessories:
   1) Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
   2) Shape: As indicated.
   3) Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 4 inches (102 mm).
   4) Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.

(ix) Height: Manufacturer's standard in height required to enclose roller and shadeband when shade is fully open, but not less than as indicated on Drawings.
   1) Endcap Covers: To cover exposed endcaps.
   2) Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

(x) Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than height indicated on Drawings.
   1) Provide pocket with lip at lower edge to support acoustical ceiling panel.
   2) Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

(xi) Closure-Panel Width: As indicated on Drawings.

(xii) Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels
with shadeband guides or other means of aligning shadebands with channels at tops.

(xiii) Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.

(xiv) Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.7 GRP FABRICATIONS

2.7.1 GRP Ladders:

1 Fiberglass-composite ladders made of pultruded tubing with internal reinforcement, where needed, to support a point load of 150 kg at middle of rung. Rungs are to be coated with abrasive material for slip resistance. Safety cages are also made from fiberglass-composite materials. Ladders shall comply with OSHA PP 1910.27 and installed to supplier's specifications. Products shall be designed with a 3 to 1 safety factor.

(a) Ultimate Tensile Strength: 206 Mpa [30,000 Psi]
(b) Ultimate Compressive Strength: 206 Mpa [30,000 Psi]
(c) Construction: fiberglass content minimum 60% glass content by weight.

2.9 LOADING DOCK EQUIPMENT

1 Movable Scissor Lift Tables: Scissors-type hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.

(a) Travel: min. 1200 mm unless specified.
(b) Capacity: min. 9000Kg. unless specified.
(c) Platform size : min. 1200mm X 1800mm unless specified.

2 Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.

3 Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.

4 Platform: Fabricate platform from heavy steel plate with beveled toe guards on all four sides to comply with requirements of MH 29.1.

5 Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform.

6 Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.

7 Scissors Mechanism: Fabricate leg members from heavy, steel-formed tube or
plate members to provide maximum strength and rigidity.

8. **Bearings:** Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.

9. **Removable Handrails:** Equip lift with handrails on two sides of platform with a single, removable chain across each end.

10. **Toe Protection:** Along entire unprotected side of lifts; painted yellow with black stripes to comply with ANSI Z535.1.

### 2.10 FIRE CURTAINS:

1. Active fire curtain barrier assemblies shall comprise of a pleated fire resistant fabric, incorporating an integral stainless steel reinforced mesh for impact resistance. This fabric is fixed at the top edge inside the head box enclosure and at the bottom edge in a bottom tray enclosure. The system is powered by an internal 24Vdc electric motor(s).

2. Active fire barrier assemblies shall meet the requirements of PAS 121 and be tested for impact to BS EN 949 to “double” the severe duty, be tested for controlled speeds in all modes including fail-safe by gravity on total power failure (must not be reliant on secondary power supplies to provide the ‘braking effect’), be tested for self-closing and mechanical resistance to BS EN 12605, be tested for fire resistance to NFPA or BS EN 1634-1 (BS EN 1363-1 & -2) whichever is more stringent, and be classified to BS EN 13501-2.

3. The motor shall contain the necessary drive mechanisms, a mechanical epicyclic gearbox retarder, electromechanical distance travel/limit switches, linked to an internal 24Vdc electromagnetic brake with regenerative braking system which allows the barrier to remain in the retracted position with all power removed from the motor unit. The motor(s) are fixed externally to the head box enclosure and are linked to the drive shaft via a sprocket connected by a chain drive.

4. The system shall also have full gravity fail-safe with controlled braking system and drive mechanisms. All working parts shall be totally enclosed and protected and shall be tested as part of the complete assembly for fire resistance to BS EN 1634-1.

5. Additionally, the motor shall be tested for operation at temperatures of 300 °C to PAS 121.

6. The assembly with the pleated fabric shall be housed in a 1.6 mm galvanized mildsteel headbox which shall be fixed to the building structure as tested in the orientation to BS EN 1634-1.

7. The complete active fire barrier assembly shall be classified as E180 EW60 C1 in accordance with BS EN 13501-2, and BS EN 14600.

8. **Guide Assemblies:** No side and corner guide rails.
2.11 READY MADE FOUNTAIN

1. Diameter : Min 42 cm
2. Sphere Top Height : min 23 cm
3. Sphere bottom /Pedestal Unit : min height 11 cm, min Diameter 46 cm
4. Pump Included
5. Shown in Bronze
Add the following new section to QCS 2014

SECTION 32
RADIATION PROTECTION
1. GENERAL

1.1 SCOPE

1. Scope: this Section is for the specification of radiation protection and specification for Lead-lined building materials and products and includes:

(a) Lead sheet, strip, and plate.
(b) Lead glass.
(c) Gypsum board.
(d) Steel hollow metal doors and door frames.
(e) Observation-window frames.
(f) Modular shielding partitions.
(g) Informational signs.

2. Work in this Section is to be co-ordinated with Electrical and Mechanical works specified in Electrical and Mechanical Lots.

1.2 DEFINITIONS

1 Lead Equivalence: The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.

2 Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV, unless otherwise indicated.

1.3 PERFORMANCE REQUIREMENTS

1 Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.

2 Materials, thicknesses, and configurations indicated are based on radiation protection design prepared by Employer's radiation health physicist. This design is available to Contractor on request.

3 Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in doors, door frames, window frames, penetration shielding, joint strips, film transfer cabinets, and other items located in lead-lined assemblies not less than that indicated for assemblies in which they are installed.

4 Lead Glazing: Unless otherwise indicated, provide lead equivalence not less than that indicated for assembly in which glazing is installed.

1.4 SUBMITTALS

1 Product Data: For each type of product indicated.
2 Shop Drawings: Show layout of radiation-protected areas. Indicate lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.

3 Show ducts, pipes, conduit, and other objects that penetrate radiation protection: details of penetrations.

4 Show details of neutron-shielding doors and frames, including anchorage to and coordination with other work. Show locations of electrical conduit and boxes for connecting door operators, door operator switches, and door interlock switches.

5 Wiring Diagrams: For power, signal, and control wiring.

6 Samples: For units with factory-applied color finishes.

7 Schedule: Provide a schedule of observation windows, doors and frames prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

8 Qualification Data: For qualified Installer and testing agency.

9 Field quality-control reports.

10 Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

1 Operation and Maintenance Data: For neutron-shielding doors to include in operation and maintenance manuals.

2 Maintenance Data: Cleaning instructions for leaded and acrylic glass.

3 Record Documentation: Record Drawings, with dimensions, showing locations of radiation protection.

4 Radiation Protection Survey: Record copy of physicist’s Radiation Protection Survey indicating measurements and evaluation of measurements of installed radiation shielding materials.

5 Manufacturer’s Certification: Upon completion of radiation protection work, Manufacturer and Installer shall furnish a certificate of compliance that all materials are in accordance with the specifications and physicist’s radiation protection survey.

1.6 QUALITY ASSURANCE

1 Installer Qualifications: Fabricator of products.

2 Source Limitations: Obtain each type of radiation protection product from single source from single manufacturer unless otherwise indicated.

3 Fire-Rated And Smoke-Control Door And Frame Assemblies: Comply with requirements of Section "Metal Work".

4 Glazing: Comply with requirements of Section "Glass and Glazing".
1.7 TESTS

1. Lead radiation shielding will be tested after X-ray equipment is installed.

2. Any additional testing required due to correction and replacement of defective work will be done at Contractor's expense.

3. Lead glass, lead lined gypsum wallboard will not be tested prior to installation.

4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Single Source Responsibility: Obtain radiation protection materials and accessories produced or distributed as standard products from single manufacturer regularly engaged in production of X-Ray shielding materials, equipment, and accessories.

6. Mock-Up: Provide a mock-up of type and size as directed by Engineer for testing purposes to verify the protection integrity of the work of this section and to establish application workmanship.

7. Rework mock-up area as required to produce acceptable work.

8. Do not proceed with remaining work until protection integrity and workmanship are approved by Engineer.

9. Approved mock-up may remain as part of the Work.

1.8 PROJECT CONDITIONS:

1. Environmental Limitations: Do not deliver or install radiation protection until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 WARRANTY

1. Warranty: Provide complete system warranty in which Manufacturer, Installer, and Contractor are jointly and severally responsible and agree to repair or replace defective products supplied under this section.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective material.

3. Warranty shall be in effect during the following period of time after the date of Substantial Completion:

4. Lead sheet shielding materials shall be warranted against defects in material, workmanship and performance for 10 years.
2. MATERIALS AND PRODUCTS

2.1 MATERIALS


2. Lead Glass: Lead-barium, polished float glass containing not less than 60 percent heavy metal oxides, including not less than 48 percent lead oxide by weight.

   Safety Glass: Fully tempered float glass.

   (a) Outer Lite: Clear float glass; thickness as indicated.
   (b) Interlayer: Clear polyvinyl butyral or cured resin of manufacturer’s standard thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
   (c) Inner Lite: Lead-barium, polished float glass; thickness as indicated.

3. Masonry Mortar: Comply with Section S13 "Masonry."

4. Grout: ASTM C 476, with a slump of 200 to 280 mm as measured according to ASTM C 143/C 143M.

5. For grouting frames of neutron-shielding doors, use coarse grout made from aggregate having a density not less than that used for concrete walls in which frames are installed.

6. Lead-Lined Gypsum Board: 12.7-mm-or 16-mm, as indicated thickness gypsum board complying with Section S24 "Finishes to Building," of width and length required for support spacing and to prevent cracking during handling, and with a single sheet of lead laminated to the back of the board.

   Provide lead sheet lining the full width of board and height as indicated on Drawings.

   Provide 75-mm-wide lead strips for wrapping metal stud flanges.

   (a) Provide 50-mm-wide lead strips for backing joints.
   (b) Provide 8-mm lead disks for covering screw heads.
   (c) Provide lead-headed nails for fastening gypsum board, accessories, and trim to wood members.

7. Accessories And Fasteners: Provide manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.

8. Asphalt Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2  LEAD-LINED DOORS AND FRAMES

1. Lead-Lined Steel Hollow-Metal Doors: Steel doors complying with ANSI/NAAMM-HMMA 861, except with a single continuous sheet of lead of thickness as indicated on Drawings and extending from top to bottom and edge to edge, installed either between back-to-back stiffeners or between stiffeners and stop face of door.

2. Line inverted channels at top and bottom of doors with lead sheet of same thickness used in door and close with filler channels to provide flush top and bottom edges.

3. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining 25 mm.

4. Lead Door Louvers: Provide louvers with 30 percent free area, of sizes and types indicated. Fabricate from formed-lead sheet or lead extrusions of not less than lead thickness required for door in which louver is installed. Fabricate louvers to be lightproof with fixed maze-type blades that maintain required lead equivalence at all points and in all directions. Factory fit and assemble louvers in doors before shipping to Project site.

5. Prepare doors to receive observation window sand louvers; cut and trim openings through doors in factory. Provide removable stops for glazed openings.

6. Provide lead-lined astragals for pairs of doors.

7. Factory fit doors to suit frame-opening sizes indicated with 1.5-mm clearance at heads and jambs and minimum clearance at bottom.

8. Finish: Apply manufacturer's factory-applied paint.

9. Color and Gloss: As selected by the Engineer from manufacturer's full range.

10. Lead-Lined Steel Hollow-Metal Frames: Steel door frames complying with ANSI/NAAMM-HMMA 861, except 1.7 mm thick, and lined with lead sheet of thickness not less than that required for doors and walls where frames are used.

11. Provide additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Install reinforcements and supports before installing lead lining.

12. Form lead sheet to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with lead of adjacent shielding.

13. Finish: Apply manufacturer's factory-applied paint.

14. Color and Gloss: As selected by Architect from manufacturer's full range.

15. Lead-Lined Wood Doors: Flush solid-core wood doors with lead lining, thickness as indicated on Drawings.

16. Door Construction: As shown on drawings.
Lead Lining: One or more continuous sheets of lead extending from top to bottom and edge to edge, constructed either in the core or between the core and faces, at manufacturer’s option.

18 Faces: Plastic laminate complying with NEMA LD 3, Grade HGS.

19 Color, Patterns, and Finishes: As selected by Architect from manufacturer's full range

20 Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.

21 Prepare doors to receive observation windows and louvers; cut and trim openings through doors in factory. Provide removable wood stops for glazed openings.

22 Provide lead-lined astragals for pairs of doors.

23 Factory fit doors to suit frame openings indicated with 1.5-mm clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.

24 Hardware Preparation: Factory prepare doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished.

2.3 LEAD-LINED OBSERVATION-WINDOW FRAMES

1 General: Fabricate from 1.1-mm- thick, formed-steel sheet or 1.6-mm- thick aluminum extrusions with mitered corners, welded or bolted with concealed fasteners.

2 Line with lead sheet formed to match frame contour, continuous in each jamb and across head and sill, lapping the stops, and fabricated wide enough to maintain an effective lap with lead of adjoining assemblies.

3 Form sill with an opening for sound transmission. Offset sound passage to make opening lightproof and to maintain required lead equivalence at all points and in all directions.

2.4 LEAD-LINED MODULAR SHIELDING PARTITIONS

1 General: Partial-height modular partitions assembled from factory-finished standard components consisting of lead-lined enameled-steel framing members, lead-lined opaque panels, lead glazing plastic vision panels, and hardware necessary for assembly and for securing to other construction. Fabricate opaque panels from honeycomb-core metal panels with polyurethane paint finish.

2 Lead Equivalence for Opaque Panels: 1.5 mm.

3 Lead Equivalence for Framing Members: 1.5 mm.

4 Lead Equivalence for Vision Panels: 1.5mm.
2.5 INFORMATIONAL SIGNS, GENERAL

1. Comply With Signage Specifications In Section 31 "Fittings."

2. Color: As selected by Architect from manufacturer's full range of colors.

3. Provide copy indicated or as directed. Provide signs of sufficient size to contain required information.

4. Indicate lead equivalence in millimeters and heights of radiation protection in millimeters.

5. Rooms where the level of protection is uniform throughout: Provide one sign for each room indicating lead equivalence of partitions, ceilings, floors, doors, and other portions of radiation protection enclosure. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.

6. Rooms where the level of protection is not uniform throughout: Provide one sign for each room with different lead equivalences in different locations. Indicate, in tabular form, lead equivalence of each wall, partition, ceiling, floor, door, and window. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height. Indicate where lead equivalence changes or is not continuous.

7. Rooms where some partitions are without radiation protection: Provide one sign for each partition that contains radiation protection and indicate its lead equivalence. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.

8. Rooms where only the door has radiation protection: Provide one sign for each door indicating its lead equivalence.
3. WORKMANSHIP

3.1 EXAMINATION

1 Examine substrates in areas to receive radiation protection, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.

2 Proceed with installation only after unsatisfactory conditions have been corrected.

3 Concrete Surfaces: Proceed with installation only after surfaces are clean, dry, and free of depressions and sharp projections that could damage or penetrate lead sheet.

3.2 INSTALLATION

1 Installation of lead sheets in concrete floor slabs:

(a) Apply a coat of asphalt mastic or paint to concrete surfaces before installing lead sheet.

(b) Before installing floor lead sheet, place lead strips not less than 175 mm wide under the base of vertical wall protection. Extend lead strips approximately 75 mm into the shielded room area.

(c) Lead Sheet, 3 mm Thick or Less: Install in a single layer with a 50-mm minimum lap at joints.

(d) Lead Sheet More Than 3 mm Thick: Install in two or more layers with a 50-mm minimum lap at joints, or in a single layer with joints butted and covered with a 100-mm wide lead strip of same thickness.

(e) Extend lead sheet at least 300 mm beyond radiation protection in walls of room.

(f) In floor slabs above shielded rooms where lead sheet is indicated, extend lead sheet at least 300 mm beyond radiation protection in walls of room below.

(g) At door openings, extend lead sheet at least 300 mm beyond radiation protection in walls and at least 300 mm beyond door opening on both sides except where lead-lined thresholds are provided.

(h) After installation, apply a two coats of asphalt coating on top surface of lead sheet and protect from damage until concrete topping is placed.

2 Installation of lead-lined gypsum board

(a) Install with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints. Install using construction adhesive and supplementary fasteners.

(b) Fastening to Metal Supports: Use steel drill screws spaced as recommended in writing by gypsum-board manufacturer. Install lead strips covering face of framing and wrap around flange to cover points of screws.

(c) Where possible, install lead-lined gypsum board before installing gypsum
board on other side of partition, and do not fold lead strips back over inside of flange until after lead-lined gypsum board is applied.

(d) Apply lead disks recessed flush with surface of board over heads of screws securing trim.

(e) Fastening to Metal and Wood Supports: Use steel drill screws spaced as recommended in writing by gypsum-board manufacturer. Apply lead disks over screw heads and recess flush with surface of board.

(f) Install lead strips, 38 mm wide minimum and same thickness as lead lining, to face of supports and blocking where joints occur. Secure lead strips with construction adhesive. Provide shims at intermediate supports.

(g) Apply lead disks recessed flush with surface of board over heads of screws securing trim.

(h) Fastening to Wood Supports: Use lead-headed nails spaced as recommended in writing by gypsum-board manufacturer. Drill pilot holes to prevent deforming nails or distorting board. Drive nail heads slightly below exposed surface.

(i) Install lead strips, 38 mm wide minimum and same thickness as lead lining, to face of supports and blocking where joints occur. Secure lead strips with construction adhesive. Provide shims at intermediate supports.

(j) Fasten accessories and trim to wood supports with lead-headed nails as specified above for fastening gypsum board.

(k) Two-Layer System: Apply a facing sheet of gypsum board vertically over base sheet using laminating adhesive recommended in writing by gypsum-board manufacturer. Offset joints in finish layer from joints in base layer and fasten at top and bottom of sheet to support finish panel until adhesive has set.

(l) Locate fasteners above ceiling or behind wall base and cover fasteners with lead disks recessed flush with surface of board.

(m) Openings: Extend lead-lined gypsum board into frames of openings, lapping lead lining with lead frames or frame linings at least 25 mm. Arrange board around openings so neither horizontal nor vertical joints occur at corners of openings.

(n) Install control and expansion joints where indicated, with appropriate trim accessories. Install lead strip on face of framing, extending across joint, and lap with lead lining of gypsum board.

3 Installation of lead-lined doors and door frames

(a) Apply a coat of asphalt mastic or paint to lead lining in door frames where lead will come in contact with masonry or grout.

(b) Glazing: Comply with installation requirements in Section S25 "General Glazing" and with door manufacturer's written instructions.

(c) Frames: Comply with HMMA 840, unless otherwise indicated. Except for frames located in existing walls or partitions, place frames before constructing walls. Set frames accurately in position, plumb, and brace securely until permanent anchors are set.

(d) Provide three anchors per jamb, located adjacent to hinge on hinge jamb and at corresponding heights on strike jamb.
(e) In masonry construction, use wire or T-strap anchors and apply a coat of asphalt mastic or paint to lead lining where lead will come in contact with masonry or grout.

(f) In metal stud construction, use wall anchors attached to studs with screws.

(g) In wood stud construction, use strap anchors attached to studs with screws.

(h) Lap lead lining of frames over lining in walls at least 25 mm.

(i) Lead Lining of Frames: Line inside of frames with lead of thickness not less than that required in doors and walls where frames are used. Form lead to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least 25 mm.

(j) Install doors in frames level and plumb, aligned with frames and with uniform clearance at each edge.

(k) Line astragals with lead sheet.

(l) Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors.

(m) Touch up damaged finishes with compatible coating after sanding smooth.

(n) Operation: Rehang or replace doors that do not swing or operate freely. Check and readjust operating hardware items, leaving doors and frames undamaged and in proper operating condition.

4 Installation of lead-lined observation windows

(a) Install observation windows according to manufacturer's written installation instructions.

(b) Apply a coat of asphalt mastic or paint to lead lining in frames where lead will come in contact with masonry or grout.

(c) Install windows level, plumb, square, true to line, and anchored securely in place to structural support.

(d) Install leaded side of frame on radiation side of wall. Lap lead lining of frames over lining in walls at least (25 mm).

(e) Glazing: Comply with installation requirements in Section "Glass and Glazing" and with manufacturer's written instructions.

5 Installation of lead-lined modular shielding partitions

(a) Install partitions after finishes are complete in spaces where partitions are located. Install according to manufacturer's written instructions and Shop Drawings.

(b) Cut and remove wall base where modular shielding partitions meet other walls so partition will fit tightly to wall.

(c) Secure partition framing to floor with (6-mm) expansion anchors (400 mm) o.c. and fasten to walls and ceilings as indicated. Brace partitions with tie rods fastened to walls or ceilings as indicated.

6 Installation of penetrating items

(a) At penetrations of lead linings, provide lead shields to maintain continuity of
protection.

(b) Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.

(c) Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners, unless indicated on Drawings.

(d) Film Transfer Cabinets: Where film transfer cabinets occur in lead-lined partitions, line wall flange with lead sheet of same thickness as required for partition where it is located.

(e) Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least 25 mm. Wrap conduit with lead sheet for 250 mm from box.

(f) Duct Openings: Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition/ceiling equal to three times the largest opening dimension. Lap lead sheet with adjacent lead lining at least 25 mm.

(g) Piping: Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than 250 mm from point of penetration.

3.3 FIELD QUALITY CONTROL

1 Testing Agency: Engage a qualified testing agency, approved by the Engineer, to perform tests and inspections after radiology equipment has been installed and placed in operating condition.

2 Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.

3.4 PROTECTION

1 Lock radiation-protected rooms once doors and locks are installed and limit access to only those persons performing work in the rooms.
Add the following new section to QCS 2014

SECTION 33

MEDICAL FURNITURE
1. GENERAL

1.1 SCOPE

1 Scope: this Section is for the specification of medical and laboratory furniture and equipment fixed to the building fabric or provided loose within the building.

1.2 RELATED SECTIONS

Section 17 "Metalwork"
Section 18 "Carpentry, Joinery and ironmongery"
Section 24 "Finishes to Building"
Section 31 "Fittings"

1 Work in this Section is to be co-ordinated with Electrical and Mechanical works specified in Electrical and Mechanical Lots.

1.3 SUBMITTALS

1 Drawings: provide co-ordination, fabrication and installation drawings and other information showing such details of the work as the Engineer may reasonably require including elevations, large scale sections and proposed methods of fixing.

2 Samples: submit samples of each type of fitting. Obtain approval of appearance and other characteristics before proceeding with manufacture or delivery.

3 Control Samples: after finalisation of details prepare one of each type medical fitting as part of the quantity required for the project and obtain approval of appearance before proceeding with manufacture of remaining quantity.
2. MATERIALS AND PRODUCTS

2.1 COMPONENTS

1 Metal, Wood and other component parts of fittings including fastenings, fixings, treatments and finishings are to be in accordance with the requirements of Sections S17 and S18 of the Specification.

2.2 SHELVING AND STORAGE FITTINGS

1 Mobile Storage Units For X-ray records and medical records to be purpose made units as shown on Drawing, consisting of mobile double sided shelf units with adjustable open shelves and vertical dividers; all steel construction with rust inhibiting primer and baked-on acrylic enamel finish; manual operating system comprising carriage and wheel assemblies and floor tracks.

2.3 LABORATORY FURNITURE

2.3.1 Frame Work:

1 worktop shall be supported on Cantilever Frames. Frames should be connected to each other by means of a front runner of size 50mm. Frame should be of rectangular box with a wall thickness of 3mm and at least of following dimensions:

   (a) vertical member of minimum 65x38mm
   (b) horizontal top member 50x38mm
   (c) horizontal bottom member 75x38mm

2 All framework should be sandblasted, primed and powder epoxy coated. Each cantilever leg shall have adjustable threaded foot of non abrasive material such as tough plastic, nylon, etc.

3 Framework should be designed for safe loading of minimum 210 kilograms per square meter.

2.3.2 Worktops:

1 Trespa: worktops for all labs except Biochemistry and Washing Sterilizing lab shall be made of 16mm Thick Phenolic Resin with rounded edges to all exposed sides. Worktop shall be Solid, high-pressure decorative laminate, complying with NEMA LD 3, Grade CGS.

2 Solid Epoxy Resin: worktop for Biochemistry Lab shall be made of 19mm thick Modified Epoxy Resin that has been especially compounded and cured to provide the optimum physical and chemical resistance required of a heavy duty laboratory working surface.

3 Stainless Steel: worktop for Washing Sterilizing Lab shall be made of 1.5mm thick Stainless Steel 304 grade with integral backsplash, and raised rim on all exposed sides. Weld stainless steel sinks on to stainless steel worktop and all welding marks to be cleaned and polished.
2.3.3 Cabinets:

1. Underbench cabinets shall be made of plywood minimum 18mm thick and melamine finish on all sides and edges. Backwall of cupboards may be provided with melamine faced hardboard set into grooves. The underbench cabinets shall be suspended onto the steel frame and should not take a direct load of the worktop. The underbench cabinets can glide along the entire length of the bench without being obstructed by the cantilever frames.

2. Wall hung cabinets shall be made of plywood minimum 18mm thick and melamine finish on all sides and edges. Backwall of cupboards may be provided with melamine faced hardboard set into grooves.

3. Free standing tall storage cabinets shall be made of plywood minimum 18mm thick and melamine finish on all sides and edges. Backwall of cupboards may be provided with melamine faced hardboard set into grooves.

4. Shelves: shelves of cupboards shall be made of plywood, 18mm thick, melamine finished on all sides and edges. They shall be adjustable for regular heights.

5. Doors/Drawer Fronts: doors/drawer front of cupboards shall have 0.9 mm thick melamine laminate on both sides and edged 3mm PVC edging using hotmelt glue at temperature of 205 degree celsius.

6. Glass Doors: sliding glass door of wall hung cupboards shall be of toughened glass, 5mm thick, mounted on Aluminum rails.

7. Ironmongery of Cupboards:
   
   (a) Hinges: should be adjustable four way and of laboratory type. They should be openable 165 degree minimum and all hinges should be self closing and can be adjusted for alignment in 4 direction. No door catches or magnets should be used. Hinges should be nickel coated.
   
   (b) Drawers: sides should be made from epoxy powder coated steel, with 12mm thick laminated plywood bottom, running on nylon runner fitted to the side wall of the cabinets.
   
   (c) Handles: should be approximately 200mm long and 10mm to 12mm in dia made of steel and with anticorrosive finish such as epoxy coating. Alternatively a full length Grabrail of anodized aluminum shall be acceptable.

8. Sizes: cupboard modules shall be in 450mm, 600mm, 900mm, and 1200mm and shall be joined together to have required size.

9. Services: service connections shall be concealed and of high class design and finish. Tubing shall be copper for gas lines, and galvanized steel for water lines. Drainage system shall be in high density polyethylene material.

10. Sinks: stainless sinks shall be made of 16/8 stainless steel for stainless steel worktop in washing sterilizing lab.

11. Solid epoxy resin sink of appropriate sizes for Trespa and solid epoxy worktop.
12 Fittings: water and gas taps shall be manufactured by international manufacturer of Laboratory fittings, to recognised colour code.

13 Electrical Fittings: refer to Electrical Specification

2.3.4 Fume Cupboard:

1 fume cupboard is placed on a steel frame of box section 30x30x1.6mm. Frame is degreased, sandblasted primed and epoxy powder coated in black and hardened to 260°C. Frame is provided with an adjustable threaded foot of non abrasive tough plastic

2 lower part of fume cupboard is provided with a two door cabinet

3 worktop of fume cupboard is made of acid resistant ceramic tiles. Fume chamber which is the upper part is lined with 3mm thick Phenolic Resin Compact Laminate same as the baffles. All edges along the sash including the worktop is curved aerodynamic in nature to nullify turbulence inside

4 the fume cupboard is provided with 5mm toughened glass counter poised safety sash supported by a counter balance with a built-in safety top. The front opening is 1200 x 900 mm in area and the depth of the clear working space is 7550mm. The linear air velocity through open front between 6-12m/minute

5 front controlled services fitted are one panel mounting gas cock with integral nozzle, water tap over a stoneware trough of size 150x150mm fitted in base with water outlet, one number splash proof switched 13A electrical outlet fixed to panel

6 extract hole of 200mm dia is cut in ceiling lining and roof to take flue and suitable fan extractor. Extract ducts projects at least one meter above the building, ending with proper covering to keep away rain water

7 extraction unit has a capacity of 850 M3 per hour. The extract fan is corrosion and explosion proof and is controlled with a DP switch and DOL starter with overload relay of correct rating

8 dimension: shall be 1200 x 900 x 2400 mm with lowered sash. Total height of fume cupboard when open sash is 2660 mm.

2.3.5 Laminar Flow Cabinet:

Performance Specification : Fed. Std.209b
Airflow Control System : 100fpm regulated by Solid State traic motor speed controller.
Motor Speed Control : One disposable extended media, dry type filter rated airflow capacity in accordance with specification MIL-F-51068
HEPA Filter : Fiberglass disposable
Prefilters : Performance Levels :
Lights: 175 foot-candles on work surface
Vibration: Less than 200 micro-inches on the work surface.
Sound: Less than 62 dba against ambient 55 dba
Standard Features: HEPEX Zero-Leak Airflow System
clear lucite hood
textured white baked enamel finish
smooth white Formica Work Surface
front Maintenance
fluorescent Light
protective Filter Grill
fiberglass Disposable Pre-Filter
full instrument Panel
magnehelic Gauge.

2.4 medical equipment

1 Headwall Units: houses all Electrical and Mechanical services to the bed as shown on Electrical and Mechanical drawings. It is to be constructed of 6063-T5 alloy aluminium extrusions and 16 ga steel panels with high pressure laminate face.

2 Prefabricated Medication Station: medi-prep medicine station constructed of polished stainless steel as follows:

(a) unit size, exterior dimensions shall be 1220 mm wide, 508 mm deep, 2032 mm high, and be furnished with sloping top
(b) medicine station configuration shall be designed for use as a floor stock unit which shall include removable four-tier medicine shelf designed so that bottles and containers are in sight and easily reached, plus two flat adjustable and removable shelves
(c) counter top shall be polished stainless steel extending full width of cabinet. Counter shall include a 241 x 292 x 152 mm deep stainless steel seamless drawn sink bowl with coved corners; equipped with a waste strainer and a combination hot and cold water faucet with wrist blades
(d) medicine card rack shall be an integral part of the outer door of the narcotics locker, situated at eye level above the counter working surface but not above the sink area; rack shall provide 24 slots, each capable of holding approximately 25 cards
(e) medicine cup dispenser and waste container dispenser for 1 oz. paper or plastic cups shall be located within unit; an opening shall be provided in rear wall for disposal of used cups into a removable waste container.
(f) Illumination shall be provided by fluorescent lamp located at front of cabinet ceiling and controlled by silent switch and an electrical outlet.
(g) Narcotics/hypnotics cabinet shall be located in the upper left section of the medicine station and be equipped with an outer and inner door, each with separate lock and key, outer door to secure hypnotic locker, inner door to secure narcotics locker; two warning lights shall be provided, both in the centre of the unit; both shall stay lit until both doors are locked. An electrical connection shall be provided for an additional remote light.

(h) Refrigerator shall be located within the medicine cabinet, shall have a capacity of 4 1/2 cubic feet, and be equipped with three perforated sliding stainless steel pans for storage of biologicals; adjustable spacing shall be provided with a lock; 1/8 HP refrigerator compressor shall be located in the medicine cabinet and shall be warranted for not less than five years.

(i) Syringe drawer shall be provided for safe storage of syringe kits and hypodermic needles and provided with a lock.

(j) All locks shall be keyed the same except lock on narcotics locker.

(k) Unit shall be equipped with an aluminum roll-up security door, keyed same as all other locks except narcotics locker.

3 Prefabricated Nourishment Station: constructed of polished stainless steel on all exposed surfaces with upper front of unit made of vinyl-clad steel. Provide unit with all standard accessories included with Model No. NIM9 as follows:

(a) unit shall include ice system including sanitary ice maker, stainless steel storage cylinder and dispenser, two hot plates, one stainless steel 356 x 406 x 165 mm sink, 9.9 cubic ft. refrigerator system, storage units with stainless steel shelves and a removable utility drawer and a coffee brewer.

(b) A fluorescent lamp located at back of work counter recessed into front of cabinet ceiling and controlled by a silent switch.

(c) All parts shall be warranted for one year from date of installation.

(d) This unit shall be shipped completely assembled.

4 Glove And Apron Rack: combination glove and apron holder, finish to be green hammer stone enamel.

5 Cassette Transfer Cabinet: lead-lined film transfer cabinets, factory-fabricated, double-wall construction, of 1.1-mm- thick, cold-rolled, stretcher-leveled, commercial-quality steel sheet free of scale, buckle, pits, and other defects. Line entire interior and doors with lead sheet not less than that required for partition in which cabinet is installed.

6 Configuration and Size: As indicated on Drawings.

7 Provide an integral flange with lead lining extending beyond rough opening at least 19 mm.

8 Provide a sound passage in cabinet frame. Offset sound passage to make opening lightproof and to maintain required lead equivalence at all points and in all directions.

9 Doors: Mount doors on full-height, concealed-leaf hinges. Label doors to one compartment "EXPOSED" and to other "UNEXPOSED." Provide a manual
interlocking device to prevent doors on opposite sides of compartments from being opened at same time.

10 Exterior Finish: Baked-on gray enamel primer.

11 Cabinet Interior: Provide each compartment with a black rubber floor. Finish interior of doors, sides, and top in a nonreflective black finish.

12 Trim: Provide face flange or separate trim on each side of wall.

13 Hardware: Provide bright, polished, chrome-plated brass hardware.

14 Rough-in Frame: Provide adjustable telescoping rough-in frame fabricated from 1.6-mm-thick, zinc-coated steel. Design frame to allow adjustment for wall thicknesses from approximately 100 to 200 mm.


16 Labels:

(a) manufacturer's standard engraved or printed labels indicating the full extent of protection in walls and doors.

(b) state Sanitary Code approved labels as to proportion, color and language.

17 Film Illuminator: 355 x 431 mm stack align film illuminator with instant start ballast in a four section factory assembled bank. Boxes shall have full width stainless steel film grips, 14 inches wide and front mounted on-off switch. View boxes shall be recessed into wall in accordance with manufacturers rough-in drawings. All view boxes shall be supplied with snap-on stainless steel molding strips to cover rough-in opening.

18 Audiometric Examination Room: single room, double wall construction 1220 x 1015 mm inside dimension supplied complete with: magnetically sealed doors, double glazed windows, self-contained ventilation, jack panels designed to be compatible with most Audiometric equipment

2.5 PRIMERS AND SEALANTS

1 Products to be used in conjunction with movement joint sealant are to be the types recommended for the purpose by sealant manufacturer.

2 Primer: type recommended by sealant manufacturer.

3 Exposed Sealant: for pointing and for movement joints in surfaces not subject to high abrasion to be one-part moisture cured silicone sealant to ASTM C920 or BS 5889, Type A complete with backing cord and bond breaker recommended by manufacturer:
3. WORKMANSHIP

3.1 GENERALLY

1 Coordination: ensure manufacturer’s standard details and fixing instructions are provided as necessary for co-ordination with related building elements and services.

2 Fabricating, Machining And Assembling of fittings are, where relevant, to be in accordance with the requirements of Sections S17 and S18 of the Specification.

3.2 INSTALLATION

1 Fixing Generally including storage and protection are, where relevant, to be in accordance with the requirements of Sections S17 and S18 of the Specification.

2 Sealant Pointing:
   
   (a) ensure that finishes to backgrounds are complete and surfaces to receive sealant are clean and dry
   
   (b) remove protective covering from fittings the minimum necessary to apply sealant
   
   (c) apply sealant in accordance with sealant manufacturer’s recommendations to give a neat, smooth, watertight joint.

3 Completion: ensure that doors and drawers are accurately aligned and do not bind. Adjust as necessary to ensure smooth operation. Check, adjust and lubricate ironmongery as necessary to ensure correct functioning.