# TENDER DOCUMENT

## (MECHANICAL SPECIFICATION)

## VOLUME – 2

## PROJECT DETAILS

**Project : MIXED USE (RESI+RETAIL) G+2P+8**

**Client : NBCC OVERSEAS REAL ESTATE L.L.C**

**Location : PLOT NO IC1-CTYL-16_013 AT WARSAN 1 -621, DUBAI, U.A.E.**

ايدماك للاستشارات الهندسية
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# MECHANICAL PARTICULAR SPECIFICATIONS

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# SECTION 01

# GENERAL REQUIREMENTS

# GENERAL REQUIREMENTS

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## 1.0 GENERAL

1.1 These specifications relate for the installation of Mechanical works. However, the instructions to Tenderers, Form of Tender, Conditions of Contract, note on pricing, Preliminaries Section and any supplementary conditions of Contract applicable to Main Contract shall be applicable to this Contract also.

1.2 The terms Contractor and Subcontractor used in the MEP documents and drawings are to be considered to mean the Contractor for MEP works.

1.3 The precedence of documents and drawings shall be as determined in the Main Contract. However, consider the specifications as an integral part of the work together with the drawings. Consider any item or subject omitted from one but mentioned or reasonably implied on the other as properly and sufficiently indicated and provide the same under the work of this division.

## 2.0 INTENT

2.1 Contractor shall be responsible for proper performance of all MEP systems in accordance with relevant standards and codes and design parameters listed hereinafter.

2.2 The scope of work shall include supply, installation, testing and commissioning the whole of the work and unless otherwise indicated, all the materials necessary to form a `complete installation' and such commissioning and testing as are prescribed in subsequent clauses and as may otherwise be required to give an effective and safe working installation.

2.3 The words `complete installation' above shall mean not only the major items of plant and equipment covered by the specifications, but also the supply and fixing of any and all incidental sundry components necessary for the complete execution of the Works and for the proper operation of the installation, whether or not these sundry components are mentioned in detail in the Contract Documents.

2.4 The Contractor is responsible for developing its own take off of materials and is to make this available as requested to the Consultant.

## 3.0 EXAMINATION OF SITE AND DRAWINGS

3.1 Visit the site of the proposed works and obtain all information as to existing conditions and limitations and all proposed works on adjacent sites and in adjacent areas which might affect the works on this site, whether by Private individuals or by Government Authorities or others.

3.2 Examine the documents including the Specifications and Drawings of all other Divisions before bidding and again before commencing any portion of the works.

3.3 Neither the Owner nor the Consultant will be responsible for any claim for extra work or expense resulting from the failure of the Contractor to be fully aware of Site Condition.

## 4.0 INSPECTIONS

4.1 Arrange for inspection of all work by the Local Authorities as and where applicable. This is to occur on an on-going basis throughout construction to avoid delays to the project. On completion of the work, present to the Consultant, for the owner, final unconditional approval certificates of the Inspecting Authorities.

4.2 Before commencing any work on site, submit the shop drawings (approved by the Consultant) to the Authorities, as and where applicable, for checking and approval. Follow the progress of such drawings to permit the timely approval of them by the Authorities. Comply with any changes requested by the Authorities but notify the Consultant immediately of any such change and obtain approval of the same.

## 5.0 CONTRACT DRAWINGS

5.1 The drawings for services works are design drawings, 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 do not intend to indicate architectural or structural details. These cannot be used as shop drawings. Contract must develop own detailed shop drawings at the site.

5.2 Do not scale drawings. Obtain accurate dimensions to structure and architectural items from drawings of those trades, confirm by site measurement, verify location and elevation of all services (Water, Electrical, Telephone, Sanitary, Storm Drainage, Gas etc.,) before proceeding with the work.

5.3 Make at no extra cost, any changes or additions to materials, and / or equipment necessary to accommodate structural conditions (pipes or ducts around beams, columns etc.).

5.4 Install all ceiling mounted components (diffusers, grills, detectors, light fixtures, 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 at site.

5.5 Leave space clear and install all work to accommodate future materials and / or equipment as indicated and / or supplied by other division of work of the contract. Install all pipe runs, conduit runs, cable trays etc., 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.

5.6 Confirm on the site the exact location of outlets and fixtures.

## 6.0 SHOP DRAWINGS, BUILDERS WORK DRAWINGS AND MATERIAL SUBMITTALS

6.1 Within 15 days of award of Contract, submit program of works. Along with the program, submit a schedule detailing proposed submission dates for all Material Submittals, Shop drawings and builder’s work drawings.

6.2 Contractor must obtain, from the Consultant, approvals of all materials, equipment and drawings with appropriate time to facilitate work at site, but, according to baseline

program, from the contract award data. This period includes any required resubmissions till final approval is obtained.

6.3 Prepare drawings in conjunction with all trades concerned, showing sleeves and openings for all passages through structure and all insert sizes and locations.

6.4 Prepare composite construction drawings, fully dimensioned of piping and equipment in shafts, and areas, and all other critical locations to avoid a conflict of trades.

6.5 Prepare drawings of equipment bases, anchors, floor and roof curbs, wall openings and trenches.

6.6 Prepare all drawings to scale as agreed with the Consultant. Forward these drawings, approved by all trades concerned by the Consultant for his records. Provide copies in a number as specified elsewhere in the Contract but not less than four sets.

6.7 Drawings production and presentation is a Contractual matter and any delay in making these submissions will be considered Contractual delay and may be subject to Contractual penalties in accordance with Contract documents.

6.8 The Consultant will only consider shop drawings bearing the stamp of the Contractor and all subcontractors involved. Check for all pertinent information such as physical dimensions, make performance, electrical characteristics and indicate the intended use and location before submitting these drawings. Use reference symbols or enumeration to correspond to the design drawings.

6.9 Assume responsibility for accuracy of equipment dimensions related to space available, accessibility for maintenance and service, compliance with inspection authority codes. Ensure that shop drawings indicate working weights of all equipment.

6.10 The submission of samples, wherever required by Consultant, will be subject to the same procedure as that of shop drawings. One set of such samples shall be required to be brought to site and kept there after approval till substantial completion.

6.11 The Consultant will mark the drawings “Approved / Approved with comments / Revise and Resubmit / Rejected”. Contractor shall resubmit accordingly.

6.12 The Consultant 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 the approval after the originally scheduled date will be considered as a delay to the contract caused by the Contractor.

6.13 The Consultant’s review shall not relieve the Contractor from responsibility for deviations from the Contract documents, unless he has, in writing, called the Consultant’s attention to such deviations at the time of submission of drawings. The Consultant’s approval shall not relieve the Contractor from the entire responsibility. Any approval by the Consultant shall be on the understanding that any item submitted shall be ordered with options and modifications to fully meet the specification. 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.

6.14 Furnish prints of the reviewed details to all the other parties who may require them for proper coordination of their work, and furnish all information necessary for the work as a whole.

6.15 Obtain Manufacturer’s installation directions to aid in proper execution of the work. Submit two copies of such directions to the Consultant prior to installation, for use in inspecting the work.

## 7.0 RECORD (AS-BUILT) DRAWINGS

7.1 As the job progresses, mark on one set of prints to accurately indicate the status of installed work. Have the prints available for inspection at the site at all times. 30 days before commissioning, finalize the as built drawings and submit 2 sets as draft to the consultant for checking and approval. Upon approval, submit one set of transparencies and three sets of prints to the Consultant for onward transmission to the Client.

7.2 Show on the record drawings the installed inverts of all services entering and leaving the Villa and the property. Dimension underground services at key points of every run-in relation to structure and Villa. Record all elevations for underground services in relation to floor level of the Villa and give reference datums to Municipal benchmarks.

## 8.0 OPERATION AND MAINTENANCE MANUALS

8.1 Upon successful commissioning, submit one draft of Operation and Maintenance Manuals for review and approval of Consultant.

8.2 Separate binders shall be used as follows:

a. HVAC

b. Electrical and Low Current Systems

c. Plumbing and Drainage

d. Any services other than above

8.3 The minimum information required is as follows:

i. Catalogues highlighting the Make, Model and other necessary details for all Material and Equipment installed.
ii. List of local Agent / Supplier for all Materials and Equipment with Telephone, Fax and Email address.
iii. Detailed description of systems operation.
iv. Procedures for preventive regular and the breakdown maintenance, with Manufacturer's Operation and Maintenance catalogue for all systems / equipment's.
v. Commissioning date for all Systems / Equipment.
vi. List of recommended spares.

8.4 Upon approval of the draft by the Consultant, submit 4 set of manuals to Consultants for onward submission to the Owner.

## 9.0 TEMPORARY SERVICE

9.1 Do not use any of the permanent service facilities during construction, unless specific written approval is obtained from the Consultant and the Owner or where specifically allowed elsewhere in the Contract documents.

9.2 In the event that mains power is not available or is not of sufficient capacity for commissioning and testing, supply, install and operate diesel generator(s) of the correct capacity.

9.3 Any generator must have full safety features and must be maintained regularly to ensure site power at all times.

## 10.0 COOPERATION

10.1 Confer with all trades installing equipment which may affect the work of this division, and arrange equipment in proper relation with that equipment installed under all divisions of the Contract.

10.2 Furnish all items to be built in by others, in time, complete with all pertinent information, commensurate with the progress of the work.

10.3 Store materials neatly and out of the way and clean up all refuse caused by the work daily.

## 11.0 PROTECTION AND STORAGE

11.1 Protect the Villa and structures from damage due to carrying out this work.

11.2 Protect all mechanical & electrical works from damage. Keep all equipment dry and clean at all times.

11.3 Cover all openings in equipment and materials. Cover all temporary openings in ducts and pipes with polyethylene sheets or caps until final connection is made.

11.4 The quality of such cover must be determined with due regard to how long it may be until final connection.

## 12.0 EXISITING WORK AND EQUIPMENT

Before Contractor undertakes work in any area, a list of deficiencies must be prepared in that area which affects the work, or which could possibly be constructed as being caused by Contractor if not noted. Any list shall be brought to the attention of the Consultant forthwith. In the event of such deficiency where list is not prepared, then Contractor shall be deemed responsible for such deficiencies.

## 13.0 SUPERVISION

13.1 The Subcontractor will maintain at site, as necessary for the performance of the Contract, qualified personnel and supporting staff, with proven experience in erecting, testing and adjusting projects of comparable nature and complexity.

13.2 Before commencing work, the Contractor will submit details of the proposed Engineers and Supervisors, including copies of their certificates. If in the Consultant's opinion, the proposed Engineer's or Supervisors are not adequately qualified or are otherwise

unacceptable, the onus is on the Contractor to submit alternates until such approval is given.

13.3 Where the Contractor's staff becomes during the Contract deficient in performance, the Contractor is to remedy the situation by immediate and appropriate replacement, to Consultant's approval.

13.4 Approval of the Contractor's Engineers or Staff shall in no way prevent the withdrawal of that approval at any time during the Contract should the Consultant so desire. In the event of such disapproval, Contractor will be required to rectify the position as stated above within 14 days.

13.5 In the event of negligent or severely detrimental behavior, the Consultant has the right to order the removal from site of any Engineer, Supervisor, or worker on a "forthwith" basis.

## 14.0 WORKMANSHIP

14.1 Install equipment, ductwork, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the satisfaction of the Consultant. Install ducts and pipes parallel and perpendicular to the building planes. Install all piping and ductwork concealed in chases, behind furring, or above ceiling, except in unfinished areas. Install all exposed systems neatly and group to present a neat appearance.

14.2 Install all gauges, thermometers etc., to permit easy observance.

14.3 Install all equipment and apparatus which requires maintenance, adjustment or eventual replacement with due allowance for this.

14.4 Install control valves to guarantee proper sensing. Shield elements from direct radiation and avoid placing them behind obstructions.

14.5 Install all panels and boards etc., to permit easy operation.

14.6 Include in the work all requirements of Manufacturers as shown on the drawings.

14.7 Replace all work unsatisfactory to the Consultant without extra cost and to the standard required by the Consultant. This applies to any item which is found to be defective in service during the maintenance period, or extended maintenance period as appropriate.

## 15.0 MATERIALS AND EQUIPMENT

15.1 All materials used on the project shall be brand new. Obtain approval of all manufacturers from the Consultant. Labeling to be done for all equipment's and its related accessories.

15.2 "New" is defined as newly manufactured, and delivered to site as such. Any Equipment which in Consultant's opinion second hand or has been mishandled before delivery to site, shall be rejected.

15.3 All materials used on this project shall bear the third-party quality assurance stamp like British Standard kitemark, UL, FM and / or other quality assurance authority as appropriate, in the opinion of Consultants.

## 16.0 CLEANING

16.1 Each day as the work proceeds and on completion, 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. Clean out dirt and debris and leave the Villa's broom clean with no strains and in a condition acceptable to the Consultant.

16.2 Where electrical rooms form part of the visible finish in the rooms, protect from over-painting etc. and give all items a final cleaning before handing over of the project.

## 17.0 ACCESSBILITY

17.1 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 materials.

17.2 Any item of equipment needing maintenance shall be located so as to be accessible for maintenance or repair without removing adjacent structures, equipment, piping, ducts or other materials.

17.3 Cleanouts shall be located to permit rodding of all drain lines. These shall be located wherever possible external to occupied areas, and to minimize spillage problems during rodding.

## 18.0 CUTTING AND PATCHING

18.1 Inform all other Divisions in time concerning required openings. Obtain the approval of the Consultant before doing any cutting.

18.2 Supporting members of any floor, wall or the building structure shall only be cut and in such a manner as approved by Consultant. All reinstatement work must be done to the same standard as the original work.

## 19.0 INSERTS, SLEEVES, ESCUTCHEONS AND CURBS

19.1 Under this section, supply necessary sleeves and other inserts to other trades.

19.2 Supply and locate all inserts, holes, anchor bolts, and sleeves in good time when walls, floors and roof are erected.

19.3 Pass insulation unbroken where pipe or duct is insulated. Size sleeves to provide adequate clearance all around.

19.4 Use the following materials for pipe sleeves:

a. Through all interior walls above grade use uPVC class 150 pipes, machine cut, flush with finished structure.
b. Through all exterior walls above use uPVC class 150 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 walls, use uPVC class 150 sleeves, machine cut. Check flashing specifications for further details.
d. Through all waterproof floors, kitchens, roofs, use uPVC class 150 sleeves, machine cut. Extend sleeves 100 mm above finished floor upwards and cut flush with underside of floor.
e. Provide 100 mm high, 100 mm wide watertight concrete curbs with 20 mm chamfered edges around all pipes passing through waterproof floors except where furred in. Read Concrete specification before proceeding with curbs.

19.5 Pack all sleeves between the insulated pipe and the sleeve or where un-insulated between the pipe and the sleeve with loose fiberglass insulation. Seal the annular space as follows:
a. For all vertical sleeves through roofs, use permanently resilient silicone-based sealing compound, non-inflammable and waterproof.
b. Split cast plates of the screw locking type may not be used. Do not use stamped steel friction type split plates.

19.6 Brace duct sleeves and box-outs to retain their position and shape during the pouring of concrete and other work.

19.7 Provide bracing for each duct at every passage through structure to prevent sagging.

## 20.0 ACCESS PANELS AND DOORS

20.1 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.

20.2 Provide the respective division of work with panels, doors or frames, complete with all pertinent information for installation.

20.3 Prepare detailed drawings showing location and type of all access doors in coordination with other trades before proceeding with installation and hand these to Contractor to obtain approval.

20.4 Size of all access doors to provide adequate access and commensurate with the type of Structure and Architectural finish. Should it be necessary for persons to enter, provide a minimum opening of 600 mm x 450 mm.

20.5 Lay-in type ceiling tiles, if properly marked may serve as access panels.

## 21.0 FLASHING

21.1 Flash all mechanical and electrical parts passing through or built into a roof, an outside wall, or a waterproof floor.

21.2 Provide uPVC sleeves with puddle flanges for services crossing water proofed walls in basement.

21.3 Provide stainless steel grade 316 puddle flanged connections where pipework penetrates walls of the water storage tank.

21.4 All flashing shall suit roof angle and shall extend a minimum of 400 mm on all sides. Leave the flashing as directed by the Contractor for him to build into the roofing system to render a completely watertight connection.

21.5 Provide counter flashing on all stacks, ducts and pipes passing through roofs to fit over flashing or curb.

21.6 Provide pipes and sleeves passing through outside walls with aluminum or copper flashings and as directed by the Consultant. All visual aspects of such sleeves to be approved by the Consultant.

## 22.0 GENERAL WELDING REQUIREMENTS

22.1 All welding shall be generally in accordance with ANSI B31.

22.2 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.

22.3 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.

22.4 All welded pipe assemblies shall be constructed so that individual welded joints do not affect each other. The distance between the centers of adjacent welds shall be not less than twice the bore diameter of the pipe.

22.5 No welded joints shall be partially completed. Any joints tacked in position must be promptly finished within the working day. The Consultant will reject all work not done in accordance with this instruction.

22.6 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 reworking, then new full-sized lengths must be supplied by the Contractor.

22.7 All filler materials which are coated shall be protected from excessive moisture changes. Filler materials or flexes which show any sign of deterioration shall not be used. If requested by the Consultant, 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.

## 23.0 TESTS FOR WELDING QUALIFICATION

23.1 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 should carry out the tests required in the presence of Consultant, or the Employer’s Insurance Inspector.

23.2 Any weld test specimens which have been suitably marked and shall be kept on site by a responsible person, so that they can be produced at any time, at the request of Consultant.

23.3 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 welder's qualification tests shall be provided by the Contractor. In the absence of any items for inspecting the welds, the Consultant may submit the finished samples to an independent laboratory for testing at the Contractor's expense.

23.4 Copies and reports of all test reports shall be promptly given to and kept by the Consultant.

## 24.0 TESTING OF WELDED PIPE WORK INSTALLATION

24.1 Testing of welded pipework installation shall be either by destructive of non-destructive test method.

24.2 The Contractor will compile a set of safety instructions concerning welding procedures for the welders and after review by the Engineer; these will be issued to the welding operatives and foremen.

24.3 The Contractor shall allow for two percent of all the welds to be radio-graphically examined.

Determination of piping sections to be tested will be designated by the Engineer.

The timing of radiographic examination of a weld or welds designated to be so examined, will be confirmed in writing by the Engineer during the installation and commissioning.

24.4 Any weld, whether radio-graphically tested or not which are considered by the Engineer to be faulty, either in whole or in part, or which have failed under hydraulic or other tests so designated by the Engineer, will be removed and replaced by the Contractor.

24.5 The faulty part of a weld may be removed by flame gouging, chipping or grinding. Otherwise, the Engineer may instruct that the portion of the works containing the fault weld to be cut out and replaced by the welding in of a new section of pipe or member.

24.6 Should any of the welder's work (as identified by the Engineer) be found to be faulty during radiographic tests, then that welder shall be removed from site and all other welds undertaken by that welder shall be checked by radiographic means and replaced as necessary at the expense of the Contractor.

## 25.0 FLUSHING AND CLEANING

25.1 Flush all fluid-carrying systems after completion as specified elsewhere. Discharge the flushing fluid through all strainers and out through line sized valves with hose ends. Clean all strainers. Repeat flushing operation to the approval of the Consultant until the water is running clear, colorless and odorless and the conductivity is no more than 30 ms/cm above the mains water.

## 26.0 INSPECTION, TESTING AND ADJUSTING

a. All the works provided as part of this Contract shall be commissioned in accordance with all relevant specifications, and codes of practice (ASHRAE / CIBSE) and to the entire satisfaction of the Consultant.
b. Carry out all tests specified. Carry out all tests required by Authorities having jurisdiction. Test equipment to the requirements of, and where necessary, in the presence of the Manufacturer.
c. Provide all equipment, labor, instruments, loading devices, incidentals and pay for all fuel, power and sundries required to carry out the tests.
d. All tests shall be arranged in cooperation with the Consultant and his 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. No test shall be considered valid unless the Consultant is present.
e. All necessary skilled and unskilled labor 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.
f. Any defects occurring at any time during the test duration shall be made good and a complete re-test shall be carried out, all at no cost to the Contract.
g. Where failures occur during a test, inspection or commissioning procedure which results in damage to the building fabric and/or any services not provided as part of this Contract, or requires subsequent builder's work to be carried out, carry out such repair work to the entire satisfaction of the Consultant at no cost to the Owner or the Consultant.
h. All 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.
i. Prepare test report forms for each test to be performed and submit these to Consultant at least two weeks prior to the commencement of any tests.
j. Duplicate signed test certificates shall be provided after each test which will be countersigned by the Consultant who witnessed the test. The test certificate shall give the following particulars:
k. Apparatus or section under test.
l. Maker's Number (if any).
m. Nature, duration and conditions of test.
n. Result of test.
o. Duplicate copies of test certificates carried out at Manufacturer's works shall be forwarded to the Consultant for approval prior to dispatch of the article at site.
p. 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 Consultant.

q. All representatives present during inspection, testing and commissioning shall be fully conversant with the system concerned and the method of system and instrument operation.
r. Manufacturer's or Specialist Subcontractor's representatives shall attend where specifically indicated elsewhere in the specification or where necessary to ensure full service and cooperation is available to the Consultant to enable the works to be tested and commissioned in accordance with the requirements of the specification.
s. All necessary precautions shall be taken to safeguard against damage during inspection, testing or commissioning. Any damage so caused shall be made good at no cost to the contract.
t. 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.

## 27.0 INSPECTION OF THE WORK

27.1 The representatives of the Owner and the Consultant will make periodic visits to the site during construction to ascertain that the work is being executed in reasonable conformity with all plans and specifications but will not execute quality control at all times. Contractor must maintain the quality control as intended in the contract documents.

27.2 Correct all deficiencies immediately as noted during field inspections.

27.3 Request in writing that a final inspection of all services. Do not issue this written request until:

a. All deficiencies noted during job inspections have been corrected.
b. All systems have been balanced and tested and are ready for operation.
c. All balancing reports have been submitted and reviewed.
d. All instruction manuals have been submitted and reviewed.
e. The cleaning up is finished in all respects.
f. All spare parts and replacement parts specified have been provided and receipt of the same acknowledged.

## 28.0 COMMISSIONING OF SERVICES

28.1 All piping systems shall be flushed, chemically cleaned and then filled with treated water, or appropriate fluid, vented as necessary, and brought to operating conditions and the flows then regulated to the design values.

28.2 All water circuits shall be balanced by means of the regulating valves provided and flow rates shall be determined on a temperature and pressure drop basis.

Flow through pumps shall be measured by relating the pressure drop across the pump to manufacturer's test curves. A copy of the test curve indicating the final operating point shall be forwarded to the Consultant.

28.3 All refrigerant systems shall be vacuumed, purged and charged according to ASHRAE standard methods. All safety controls and interlocks will be tested as part of the commissioning procedures.

28.4 All ventilating systems shall be commissioned in accordance with the procedures recommended in the AABC Manual. Duplicate schedules of commissioning results shall be forwarded to the Consultant and shall detail the recorded air volume and percentage deviation from design air volume, for each air input and extract terminal. Wet and dry bulb temperature measurements shall be taken in all rooms served by air supply systems and the results indicated on the schedule of commissioning results.

These shall be recorded together with external ambient wet and dry bulb temperatures measured at hourly intervals over the measuring period.

28.5 All automatic controls shall be commissioned by the controlled supplier.

28.6 Following proving tests, all installations shall be left in working order ready for handover.

28.7 All electrical systems shall be tested and commissioned in accordance with IEE regulations and local authority codes.

## 29.0 SYSTEM ACCEPTANCE

29.1 The ultimate condition for system acceptance is that the Owner and the Consultant have inspected the system and found it to be acceptable and indicated this in writing.

Issuance of the final payment certificates does not necessarily indicate system acceptance, neither does release of final payment holdback in whole or part. The Consultant's acceptance may be contingent on any or all the following if applicable:

29.1.1 Submit original copies of letters from manufacturers if all systems indicating that their technical representatives have inspected and tested the respective systems and are satisfied with the methods of installation, connections and operation.

29.1.2 Submit "as built" drawings and operation and maintenance manuals.

29.1.3 Train Owner's maintenance staff.

## 30.0 CORRECTION AFTER COMPLETION

30.1 Remedy all work in accordance with the General conditions of contract during the maintenance period.

30.2 Attend immediately to any and all the defects occurring during the period defined above and repair in a manner to prevent recurrence. This Contractor is responsible for all work required by other trades necessary to repair the works of this section, or necessary to repair damage caused by the failure of any part of this section.

30.3 Instruct all Suppliers and Manufacturers that guarantees on equipment will commence when the completed work is completed and not from the date, the equipment is put

into operation. In the event that this condition is omitted by the supplier, or if subsequent cost to the Owner is involved, Contractor shall be liable for such costs.

## 31.0 GUARANTEES

31.1 The Contractor will guarantee all material and workmanship for at least 24 months after preliminary take over by the Owner.

31.2 All guarantees from 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.

31.3 Guarantees will be full guarantees and will include all overhead, profit, incidental charges and sundries.

31.4 Where damage is caused to any other item by any failure of the item guaranteed, then the guarantee shall also include the costs incurred in rectifying that damage.

## 32.0 MAINTENANCE

32.1 Maintenance is defined as the Contractual Liability to maintain the equipment in working condition, plus the regular checks and servicing of equipment during the maintenance period, including all the consumables and spare parts to keep the equipment in best order.

32.2 Regular maintenance shall be necessary, but in any event not less frequently than monthly. Breakdown calls shall be attended promptly.

32.3 Maintenance period shall be 1 year from the date of handing over for all MEP works.

**– End of Section –**

SECTION 02

INSULATION

**SECTION - 02**

**INSULATION**

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## 1.0 GENERAL

1.1 All insulation shall be in accordance with British Standard Specifications and Codes of Practice in all respects. Insulation meeting A.S.T.M. C 1427 Standards will be considered if properly submitted.

1.2 In addition to complying with the relevant standards, all insulating material shall be free from Asbestos.

1.3 The insulation material shall be with the following properties:

a. Corrosion risk assessment DIN 1988 / 7 certified.

Material should be nitrite free and can contain no more than 0.2% of ammonia.

Insulating material for stainless steel must contain no more than 0.05% of water soluble chloride ions".

Corrosion risk assessment values shall be governed by a Third party Supervisory Control Agreement which shall be available for attestation of conformity purposes.

b. Noise reduction DIN 4109 upto 32 dB (A).

c. Manufacturer shall be certified in accordance with ISO 9002 / UNI EN 29002 which includes production control procedures and systems as a pre - requisite.

d. All tests should be conducted by independent, accredited institutes like FIW, and the supervisory (third party) control agreements should be available for attestation of conformity purposes.

1.4 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.

Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

1.5 In order to ensure that the insulation applied is in all respects in accordance with the specification, sections shall, as required by the Consultant, be cut from the finished insulation.

If, however, defects are revealed, further sections shall be cut out for inspection, and all cutout sections shall be replaced at no cost to the Contract.

If further defects are revealed then the Consultant shall have the right, when in his opinion it is necessary, to issue instructions for any part or the whole of the insulation to be removed and replaced. The replacement with new insulation shall be to the satisfaction of the Consultant and the cutting out and replacing shall be at no cost to the Contract.

1.6 Any rough, irregular and badly finished surfaces shall be stripped down and re-insulated to the Consultant's satisfaction.

1.7 All systems are to have been tested and approved by the Consultant prior to installation of insulation.

1.8 All duct and pipe insulation shall be tested in accordance with test methods BS 476 Parts 6 and 7, and meet “Class 0” fire performance.

ADHESIVE TAPE

Tape shall use reinforced aluminum foil of minimum 9 micron thickness and minimum width 50mm to provide vapor sealing of insulated ducts and pipes.

Adhesive shall be suitable for indoor and outdoor use and in high humidity environments.

Adhesive tape shall meet “Class 0” requirements when tested for fire performance to BS 476 Parts 6 and 7.

OTHER ACCESSORIES

All glues, 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.

## 2.0 REFERENCE STANDARDS

- NFPA 90A and NFPA 90B: Standard for Installation of Air Conditioning Systems.
- ASTM C411: Hot-Surface Performance of High-Temperature Thermal Insulation.

- ISO 354: Acoustics – Measurement of Sound Absorption in a Reverberation Room.
- ASTM E96: Vapour Permeability of Materials.
- ASTM C518: Thermal Conductivity of materials.

## 3.0 COLD AIR DUCTS

OPTION 01

3.1 Supply air ducts for all ductwork shall be insulated with the following specifications:

i. Physically cross-linked, closed cell polyolefin foam with factory applied reinforced UV and puncture resistant aluminium foil and factory applied acrylic adhesive backing.

ii. Exceed the minimum thickness to prevent condensation.

iii. Density: 25 kg/m3 (foam core only).

iv. Thermal Conductivity (ASTM C518): Maximum 0.032 W/m.°K at mean temperature 23°C.

v. Schedule of thicknesses (must exceed minimum thickness to prevent condensation):

| S/No | Duct | Area | Thickness (mm) | Material | Jacketing |
|---|---|---|---|---|---|
| 1 | Ducts | Indoor air-conditioned area | 19mm | Elastomeric Nitrile Rubber insulation (class 0). In-built Vapour Barrier and approved by DCD & DCL to be used as a system with the adhesive. | 0.8mm aluminum hammer clad or 200 micron aluminum faced For: Exposed in Parking Garages, Mechanical rooms, roof, exposed to view and where exposed to mechanical loads |
| 2 | Ducts | Indoor unconditioned area | 32mm | | |
| 3 | Ducts | Out door and exposed | 50mm | | |

Ensure that the substrate surface is clean, dry and at ambient temperature prior to installation.

Seal all joints with specified reinforced aluminium foil tape.

The same foil faced physically cross-linked material is to be used for insulating the flanges (minimum 150mm width) and hanger supports. Direct contact between duct insulation and hanger shall be avoided.

OPTION 02

3.2 Material: Provide glass fibre insulation material with a vapour barrier jacketing having the following properties and complying with all reference standards in section 1.3:

- Thermal Conductivity: 0.038W/m°C at a mean temperature of 23°C and suitable to work properly under 50°C ambient temperature.
- Temperature Limits: -51°C to 232°C.
- Insulation density: 48 kg/m3.

3.2.1 Insulation thickness to conform to the following:

- Schedule of thicknesses (must exceed minimum thickness to prevent condensation):
- Indoor ducts (conditioned area): minimum 25mm with canvas and foster.
- Indoor ducts (unconditioned area): minimum 38mm with canvas and foster.
- Outdoor ducts (exposed): minimum 50mm with canvas and foster.

3.2.2 Apply 6-ounce canvas fabric wrap on all completed duct work insulation, finished with 2 coats of approved fungus resistant mastic such as to form a complete vapour barrier.

3.2.3 Cladding: Provide 0.80 mm thick corrosion resistant aluminium sheeting for insulated ducts installed in outdoor locations, fan rooms and mechanical rooms and two coats of waterproof sealing mastic. Cladding shall be fixed with self-tapping stainless-steel screws, with all necessary accessories.

## 4.0 ACOUSTIC INSULATION

4.1 Supply, return and extract air ducts for all ductwork shall be insulated with minimum 15mm thick physically cross-linked partially open-cell polyolefin foam with factory applied reinforced aluminium foil. Insulation shall have the following specifications:

i. Physically cross-linked, partially open-cell polyolefin foam with factory applied reinforced aluminium foil and factory applied acrylic adhesive backing.

ii. Density: 25 kg/$m^3$ (foam core only).

iii. Thermal Conductivity (ASTM C518): Maximum 0.035 W/m °K at mean temperature 23°C.

iv. Service Temperature Range: - 80°C ~ +80°C (adhesive backing).

v. Noise Reduction Coefficient 0.40 (ISO 354).

4.2 Ensure that the substrate surface is clean, dry and at ambient temperature prior to installation.

4.3 Seal all joints with specified reinforced aluminium foil tape.

**5.0 LAGGING ADHESIVE**

5.1 Adhesive shall be a flexible, fire resistive compound suitable for vapour sealing insulated ducts and pipes.

5.2 Adhesive shall be suitable for indoor and outdoor use and in high humidity environments.

5.3 Water vapour permeance shall not exceed 0.05 perms at 0.030-inch dry film thickness when tested in compliance with ASTMF 1249.

5.4 When tested for surface burning characteristics in compliance with ASTM E84, flame spread shall be 10 and smoke developed 15.

5.5 Adhesive shall be UL classified and shall meet or exceed the requirements of NFPA 90A and 90 B 25/50.

**6.0 PIPEWORK INSULATION (Hot Water and Refrigerant)**

6.1 **Building Internal Areas**

6.1.1 Water pipes, other than pre-insulated pipes and hot water pipes embedded in block walls, shall be insulated with physically cross-linked polyolefin foam with factory applied reinforced aluminum foil. Insulation shall have the following specifications:

i. Exceed the minimum thickness to prevent condensation.

ii. Density: 25 kg/$m^3$ (foam core only).

iii. Thermal Conductivity (ASTM C518): Maximum 0.032 W/m °K at mean temperature 23°C.

iv. Service Temperature Range: - 80°C ~ +100°C.

v. Schedule of thicknesses (must exceed minimum thickness to prevent condensation):

a. Domestic hot water: minimum 20mm.

6.1.2 Ensure that the substrate surface is clean, dry and at ambient temperature prior to installation.

6.1.3 Position the longitudinal seam on the bottom half of the pipe. Seal all longitudinal and butt joints with suitable contact neoprene (rubber) based contact adhesive, followed by applying specified reinforced aluminium foil tape.

6.1.4 For refrigerant piping, also seal gaps and joints between the insulation and the pipe supports/blocks, with suitable contact neoprene (rubber) based contact adhesive.

6.1.5 Insulate and finish fittings using the same foil faced physically cross-linked material for insulating pipework.

6.1.6 Check that the thickness of the pipe support insulation corresponds with the insulation being used or to specifications. The pipe support insulation shall be of sufficient width to avoid being crushed due to the pipe weight.

6.1.7 Cover the pipe support insulation with “Class 0” fire rated reinforced aluminium foil adhesive tape.

6.1.8 Any piping passing above & through the living spaces of the building shall be provided with Acoustic Sound Proof piping complete with insulation complied to the DM standards, BSEN 1329 EN14366 (12 dB at 2/ls flow rate ) to engineers satisfaction.

6.2 External to the Building, Installed on Roof

6.2.1 Material: Provide glass fiber preformed pipe insulation material wrapped with a vapour barrier jacketing having the following properties and complying with all reference standards mentioned:

- Thermal Conductivity: 0.038W/m°C at a mean temperature of 23°C and suitable to work properly under 50°C ambient temperature.
- Temperature Limits: -51°C to 232°C.
- Insulation density: 64 kg/m3.

- The insulation shall comply with BS 476 part6 & 7 (class 0), ASTM E84, FM approved for all thicknesses used.

Domestic Hot, re-circulating Hot Water Piping: Insulation shall be 25 mm thick of closed cell elastomeric rubber insulation for pipe sizes up to 50 mm.

6.2.2 Cold water pipe shall be insulated only on Roof area.

6.2.3 Apply 6-ounce canvas fabric wrap on all completed pipe work insulation, finished with 2 coats of approved fungus resistant mastic such as to form a complete vapour barrier.

6.2.4 Provide 0.80 mm thick corrosion resistant aluminium sheeting for insulated piping installed in outdoor locations and two coats of waterproof sealing mastic. Cladding shall be fixed with self-tapping stainless-steel screws, with all necessary accessories.

6.2.5 Refrigerant pipes shall be thermally insulated with molded factory shape sectional pipe covering closed cell elastomeric foam rubber insulation with density 65kg/$m^3$ having a thermal conductivity factor less than 0.035 W/m.k at 23°C and 0.040 W/m °K at 40°C and not higher than 0.042 W/m °K for temperature up to 50°C.

6.3 Domestic Hot, Re -circulating Hot Water Piping

6.3.1 Insulation shall be 25 mm thick of closed cell elastomeric rubber insulation for pipe sizes up to 50 mm.

6.4 Drainage (Building Occupied Areas)

6.4.1 Unless otherwise indicated on drawings, the following drainage piping shall be sound proof pipes or insulated with minimum 15mm thickness physically cross-linked polyolefin foam with factory applied reinforced aluminium foil as described for water pipes:

- All horizontal drainage pipework within false ceiling voids above occupied spaces and all elbows connecting these pipes to vertical stacks.
- Any piping specifically noted.

## 7.0 EXECUTION

7.1.1 The insulation shall be installed in accordance with the manufacturer's printed instructions.

7.1.2 Particular attention shall be paid to the finished appearance of all thermal insulation which must present a neat and symmetrical appearance running true in line with pipe layouts, etc.

7.1.3 Any rough, irregular and badly finished surfaces around ductwork, pipework and associated fittings shall be stripped down and re-insulated to the Consultant's satisfaction**.**

## 8.0 SAMPLES

8.1 Submit samples of all types of insulation for approval.

8.2 Submit with samples, the full technical brochures.

8.3 Where the specification calls for additional treatments, such as wrapping and waterproofing, submit also a completed sample of similar size.

8.4 All samples after approval are to be retained on site to be a reference for future work.

### 2.0.1 Pipe insulation Thickness

#### 2.2.8.1 Cold Water Pipe Work Insulation Thickness Shall Be as Follows:

| S/No | **Piping** | **Area** | **Thickness (mm)** | **Material** | **Jacketing** |
|---|---|---|---|---|---|
| 1 | Hot water supply | Indoor conditioned area | 19 | Elastomeric Nitrile Rubber insulation (class 0). In-built Vapor Barrier and approved by DCD & DCL to be used as a system with the adhesive. | 0.8mm aluminum hammer clad or 200 micron aluminum faced For: Exposed in Parking Garages, Mechanical rooms, roof, exposed to view and where exposed to mechanical loads |
| 2 | Cold water supply | Roof , shafts and parking | 19 | | |

Notes:

1. For insulation within the Equipment Rooms – follow the respective requirements as identifiedfor unconditioned space.

**2.2.8.2 REFRIGERANT AND GAS LINES INSULATION thickness shall be as follows:**

| S/No | Piping | Area | Thickness (mm) | Material | Jacketing |
|---|---|---|---|---|---|
| 1 | Ref. pipes | Indoor air-conditioned area | 13 | Elastomeric Nitrile Rubber insulation (class 0). In-built Vapor Barrier and approved byDCD & DCL to beused as a systemwith the adhesive. | 0.8mm aluminum hammer clad or 200-micron aluminum facedfor: Exposed in Parking Garages, Mechanical rooms, roof, exposed to view and where exposed to mechanical loads |
| 2 | Ref. pipes | Indoor unconditioned area | 19 | | |
| 3 | Ref. pipes | Outdoor unconditioned area | 25 | | |

Notes:

2. For insulation within the Equipment Rooms – follow the respective requirements as identifiedfor unconditioned space.

**2.2.8.3 Chilled Water Pipe Work Insulation Thickness Shall Be as Follows:**

| S/No | Piping | Pipe size inch (mm) | Thickness inch (mm) | Jacketing |
|---|---|---|---|---|
| 1 | Chilled water pipe supply and return air-conditioned area | Up to 50 | (25mm) | 0.8mm aluminums hammer clad or 200 micron aluminum faced for: Exposed in Parking Garages, Mechanical rooms, roof, exposed to view and where exposed to mechanical loads |
| 2 | Chilled water pipe supply and return air-conditioned area | Above 50 | (32mm) | |
| 3 | Chilled water pipe supply and return (risers and non-air conditioned area) | All | (50mm) | |

**2.2.8.1 Chillers condenser water pipe lines insulation shall be as follows:**

| S/ No | Piping | Pipe size inch (mm) | Thickness inch (mm) | Materia | Jacketing |
|---|---|---|---|---|---|
| 1 | Chiller condenser water pipe lines (supply and return pipes) from chillers up to the cooling towers | All | (25 mm) | Elastomeric Nitrile Rubber insulation (class 0). In-built Vapor Barrier and approved by DCD & DCL to be used as a system with the adhesive | 0.8mm aluminum hammer clad or 200 micron aluminum faced for: Exposed in Parking Garages, Mechanical rooms, roof, exposed to view and where exposed to mechanical loads |

**Condensate drain pipe lines insulation thickness shall be as follows:**

| S/ No | Piping | Pipe size inch (mm) | Thickness inch (mm) | Jacketing |
|---|---|---|---|---|
| 1 | Condensate drain pipe lines impeded inside the walls | All | (12mm) | |
| 2 | Condensate drain pipe lines (All other areas) | | 19 mm | 0.8mm aluminumhammer clad or 200 micron aluminum faced For FAHU drain pipes |

**– End of Section –**

SECTION 03

PLUMBING WORKS

**SECTION - 03**

**PLUMBING WORKS**

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## 1.0 SCOPE OF WORK

1.1 The work shall include design check, supply, installation, testing, commissioning, adjustment and setting to work of the water services installation.

1.2 By virtue of carrying out a check on the complete design, the contractor is to assume full responsibility for the correct functioning of the system and to carry any liability or guarantee as may be necessary to protect all parties in this regard.

1.3 The plumbing services subcontractor shall be responsible. for coordination with other trades and services and shall provide all materials, labour and supervision, equipment; tools, appliance, services, etc. for carrying out the following items of works:

- Domestic hot and cold water installations.
- Thermal and protective insulation of pipework, and equipment installed within the plumbing and drainage contract.
- Protective painting of all materials installed within this section of the contract. Identification of all services.
- Electrical power and control panels for power supply to equipment including cabling from panels to respective equipment. Power supply terminating in an isolating switch terminating within 3 meters of each equipment shall be provided by the electrical subcontractor.
- All builder's work including breaking and making good of walls, floors, etc., equipment foundation pads, sleeves, etc.

## 2.0 SERVICES DESCRIPTION

2.1 System Design

The plumbing system shall be designed in accordance with the recommendations of the Chartered Institution of Building Services Engineers and to the requirements of the Local Authorities. The system shall be installed as detailed in the drawings.

## 3.0 PIPE WORK INSTALLATION: GENERAL

3.1 Pipe materials shall be as specified elsewhere herein. The Contractor shall install unions or pairs of flanges in the pipework system at the following locations:-

- At intervals not greater than 15 m.

- To enable the disconnection of all items of equipment, pumps and valves for maintenance purposes.
- To enable sections of pipework to be subsequently dismantled and fixed without disturbing other pipework, plant, equipment and building fabric.
- Where indicated on the drawings.

3.2 Pipework shall be run neatly, parallel to walls or grid lines on plan and shall, where necessary, set around columns and projections. All vertical pipes shall be plumb. Direction changes in pipe groups shall be set out from a common center point.

3.3 All screwed and flanged joints shall be easily accessible.

3.4 Where pipes are fitted around columns or piers, the direction change shall be made using short sets and shall be supported from the floor on the center line of the column.

3.5 It shall be the responsibility of the Contractor to ensure that the pipework systems are at least 150 mm from any electrical conduit, cable or wiring.

3.6 Pipes entering or leaving trenches or ducts, shall be square to them. All pipework shall be fixed in such a manner as to be readily accessible for tools, welding operations or removable without dismantling adjacent pipework.

3.7 Where pipework passes through walls, etc., the Contractor shall ensure that these pipes are not subsequently bedded-in by making good by other trades.

3.8 Pipework passing through brick or concrete shall be enclosed in a steel pipe sleeve of such diameter that the pipe maybe removed without cutting or deforming the pipework. In particular where plastic pipes pass through a fire rated wall, fire arresting sleeves shall be used with a packing of intumescent strip between the pipe and sleeve.

## 4.0 STORAGE AND PROTECTION

4.1 The Contractor shall ensure that all pipework and fittings delivered to the site for inclusion in the Works are stored in an approved manner to avoid deterioration due to accidental damage and atmospheric conditions.

4.2 All pipework components should, at all times, be stored in a location offering protection from direct sunlight, i.e. from ultra violet light and the associated heating effect, it being remembered that materials close to the ground will be heated by reflection in sandy locations.

- All pipes should be protected from direct sunlight and heat of the sun by providing shaded areas.

4.3 Any part of the pipework installation which, in the opinion of the Engineer, is sub-standard, unduly distorted, marked by tools or in a deteriorated condition shall be removed and replaced at the expense of the Contractor.

4.4 Before final erection, all pipework shall be free of scale, rust, oil or other forms of corrosion. Such defects shall be removed and the pipework made good in a manner approved by the Engineer. Any stoppage or restriction occurring after the pipework systems have been put into operation which is attributable to neglect by the Contractor shall be rectified by the Contractor at his own expense.

4.5 The open ends of all pipes prepared for welding, shall be protected by plastic plugs. Plugs of paper, cardboard, cotton waste, hessian or similar material will not be permitted.

4.6 Open ends of all pipes intended for threading shall be provided with either a protective cap or screwed socket to protect the threaded ends of pipe in addition to the plastic plug.

## 5.0 PIPEWORK SUPPORTS

6.1 All pipework shall be adequately supported. All support installations shall be in accordance with relevant British Standard Specifications and Codes of Practice, except where modified or extended by the contract documents.

6.2 Supports shall allow free movement for expansion or contraction of pipework and shall be located to ensure that pipework branches or fittings are not fouled by the support during expansion or contraction of the pipework service.

6.3 Double banking of pipework from a single support position will be permitted, provided the normal operating temperature of the fluids in the two pipes do not differ by more than 30 degrees C., but only where space restrictions prohibit individual support. Triple banking will not be permitted.

6.4 Where double banking is necessary, the larger of the two pipes shall be uppermost, and where pipes are the same size but manufactured from different materials, then the pipe having the material with the lowest coefficient of expansion shall be uppermost. Support intervals for double-banked pipework of different sizes shall relate to the smaller size.

6.5 Vertical rising pipes shall be supported at the base and the support shall withstand the total weight of the pipe and fluid contained.

6.6 Supports shall not be permitted which clamp the pipe so that it is in contact with building fabric or structure.

6.7 Pipework shall be supported as recommended by the manufacturer as required in the specification and in particular on both sides of all changes in direction. Pipework shall be supported such that no load is imposed upon plant machinery. Pipework shall be supported at intervals not exceeding the following:

All pipe supports shall be manufactured in accordance with BS. 3974 Part 1: 1974.

## 6.0 PIPE EXPANSION

7.1 Pipework shall be supported in such a manner as to permit free movement due to expansion and contraction. Pipework supports shall be arranged as near as possible to joints and changes in direction and each support shall take its share of the load. The spacing of the supports shall not exceed the intervals given elsewhere herein. Where there are two or more pipes the support spacing may be based on the centers required by the smallest bore pipework.

7.2 Vertical rising pipework shall be supported at the base or as indicated to carry the total weight of the riser. Branches from risers shall not be used as a means of support for the riser.

7.3 Provision for movement due to expansion and contraction shall be made either by loops, special expansion joints or by changes in direction of the pipework. Supports at such points shall be arranged to ensure that all movement is taken up by the loop, joint or change in direction of the pipework.

## 7.0 AIR VENTING

8.1 Automatic air eliminators shall be provided at all high points in water pipework system. They shall be installed at the highest points of the sections they are intended to vent.

Insect screen shall be provided on all open vents and overflows.

8.2 Air vents on water systems shall be of float type, air eliminator of approved manufacture, having bottom inlet and top outlet with screwed connections. They shall have a stainless steel float valve and valve seat, incorporate a stainless steel check valve and shall be so designed as to allow the internal parts to be removed for maintenance

or inspection without disturbing pipework. Air vents shall be suitable for the system pressures and temperatures. An air release pipe shall be connected to the air outlet and taken to the nearest suitable discharge point.

## 8.0 WATER HAMMER ARRESTORS

9.1 Water hammer Arrestors to be provided as shown on the drawings or not.

9.2 Sizing and Location

When a unit of equipment is remote end of a long run of piping, water hammer arrestor should be placed as close to the point of valve closure as possible.

Proper sizes should be selected as per Plumbing & Drainage Institute Standard WH-201.

## 9.0 Valves

9.1 Valves shall be provided to isolate each item of plant and each main branch.

9.2 The Contractor shall make all reasonable attempts to ensure the manufacture of valves is consistent throughout the whole of the installation in order to minimize stock holding of spares.

9.3 All valves shall be located so as to provide easy access for operation and servicing. Control valves shall normally be installed in horizontal lines with stems vertical.

9.4 Provide all supply lines to bidets with check valves.

9.5 Provide cold water supply to water heaters with check valves.

9.6 Provide angle valves for incoming water supply to all fittings.

9.7 Provide back flow preventer at connections to all laundry and kitchen equipment as required by BS 6700.

9.8 Gate valves up to 50mm dia. shall be bronze body with threaded ends bronze wedge disc, high quality packing and gland, non-rising stem with screwed bonnet.

9.9 Valves shall always be installed in accessible locations to permit easy operation and maintenance.

9.10 Valves shall be pressure rated for 16 bar.

## 10.0 STRAINERS

10.1 The Contractor shall install strainers in the pipeline for pumps.

10.2 Strainers shall be suitable for withstanding the maximum operating temperature and pressure of the pipeline in which they are installed.

10.3 Install strainers in pipeline before all equipment as recommended by equipment manufacturers.

10.4 Strainers

Strainers size up to 50mm dia shall be bronze body with threaded ends and open mesh metal screen.

## 11.0 BOOSTER PUMP

11.1 DESCRIPTION

11.1.1 The variable speed domestic pressure boosting system shall be a fully automatic, compact, self-contained unit complete with pump, non-return valve, union couplers and all required fittings including pressure vessel for controlled on/off function, all assembled as a single unit or package ready for plug and pump operation. An integrated VFD with integrated software suitable for fully automatic speed controlled operation with all protection features as applicable for the system shall be an integral part of the Booster system.

11.1.2 The main controller shall be a standard PI controller developed for the pumps in use and shall be documented in the manufacturer's catalogue where only the settings and parameters should be changeable whereas the programming should be non-changeable.

11.2 STANDARDS AND APPROVALS

11.2.1 The complete packaged water booster pump system shall conform with the following standards (as applicable):

- EN 809: 1998 - Pumps and pump units for liquids. Common safety requirements.
- EN 60204-1: 2006 - Safety of machinery. Electrical equipment of machines. General requirements

11.3 DESIGN &PERFORMANCE CONDITION

11.3.1 The booster systems should be able to operate with a positive inlet pressure (pre-charged pressure system) or with a negative inlet pressure (i.e. vacuum at the inlet manifold).

11.3.2 Maximum operating pressure of the pumps in the system combined with the inlet pressure at site should not exceed the maximum allowable operating pressure of any component, fitting or pipework in the hydraulic circuit.

11.3.3 Maximum noise level 47 db(A) in typical use.

11.3.4 Ambient temperature: 0 °C to +55 °C.

11.3.5 Max. relative humidity: 95 %.

11.3.6 Suitable for outdoor installation (IP class:X4D and enclosure type 3 (US)

11.4 PUMP

11.4.1 The pumps shall be of the multi-stage design or horizontal multistage close-coupled design.

11.4.2 The pump shall be suitable for lifting water up to 3 floors and minimum 12 number of domestic taps/outlets at a pressure of minimum 1.5 bar at all outlets without drop in pressure.

11.4.3 The pump should be reliable enough to the extent that it should be able to remove air in the pipe in case of air bubbles getting trapped in the pipework.

11.5 ELECTRIC MOTOR

i. The pumps used in the system shall be fitted with a high efficiency motor with variable speed drive and suitable protection features.

ii. The PI controller shall be integrated with the motor and shall have its own built-in protection within the motor to ensure optimum reliability without the need for external control panel and protection devices.

iii. The motors shall incorporate thermal protection against slow overloading and blocking.

11.6 WARRANTY

The equipment/system shall be warranted to be free of defects in material and workmanship for a period of 30 months from handover.

11.7 ACCESSORIES

Optional accessories, installation kits etc. shall be provided/offered by manufacturer as wear parts, and as well as components.

11.8 SPARE PARTS

Service parts, spare parts, tools for repairs shall be documented in the service catalogues and should be offered by the manufacturer.

## 12.0 PACKAGED WATER PUMPSETS (CONSTANT SPEED)

12.1 The Water transfer pump set shall be a completely packaged factory assembled and tested unit complete with all major components, instruments, safety devices, stop-valves and pre-wired control panels.

12.2 Pumps shall be of the End suction or Vertical Multistage type, to match the capacity indicated on the drawings. A standby pump Jockey Pump and Pressure vessel shall also be provided.

12.3 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.

12.4 For dry run prevention of the pump, following shall be provided.

12.4.1 Plastic float with micro switches to stop the pump when water level reaches preset low level in the storage tank.

12.4.2 A flow sensor in the suction line to stop the pump if 'no-flow' status is sensed.

12.5 The pressure vessel/receiver shall be constructed in accordance with BS. 487 Part 1, and shall be coated internally with epoxy resin. The vessel shall contain a butyl rubber diaphragm which shall be removable for inspection for replacement.

12.6 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.

## 13.0 HYDROSTATIC TESTING OF WATER PIPING SYSTEMS

13.1 All water piping systems shall be hydrostatically tested for at least 1.5 the working pressure for ensuring complete tightness under the test pressure and for the duration of time as specified under the respective system concerned.

13.2 Systems may be tested as a whole or in sections to facilitate the progress of the work.

13.3 No pressure shall be applied against the closed gate of gate valves. All valves shall be in the open position but not completely back seated during testing. End valves shall be capped.

13.4 All piping that can be damaged by end thrust developing from hydrostatic testing shall be properly anchored during testing especially at changes of direction.

13.5 The piping system to be tested shall be closed by plugging and blanking all openings in the system in an approved manner and filled slowly with water making sure to vent all entrapped air. Plugs shall be released temporarily to ensure that water has reached all parts of the system.

Pressure shall be applied to the system by means of a hand pump drawing from a water container. The pump discharge shall be connected to the system through a globe valve, check valve and recently calibrated pressure gauge of suitable range to have the test pressure read in the middle of the range.

13.6 After the test pressure is reached, the pump shall be blocked off by closing the globe valve and the variations of pressure in the system monitored on the pressure gauge.

13.7 The test pressure shall be maintained on the system for 24 hours during which time the system shall have no noticeable drop in pressure.

13.8 While the system is under pressure, a careful inspection shall be made of all pipes and joints and if any leaks in joints or evidence of defective pipe or fitting is disclosed the defective work shall be corrected immediately by replacing defective parts with new joints and materials. No make shift repairs or application of any repair compound will be permitted.

13.9 After the correction is made the pressure test shall be repeated until a completely tight system is ensured.

13.10 The test pressure shall be released slowly so as not to produce shocks and sudden contractions that might damage the piping.

**14.0 TESTING OF EQUIPMENT**

14.1 After installation, all equipment shall be tested for performance and proper functioning and for demonstrating to the full satisfaction of the Engineer that the equipment meets the design requirements as shown on the Drawings and as specified.

14.2 Should any equipment prove defective, unsatisfactory or does not comply with the Specification, the Contractor shall correct, repair or replace such equipment or his own account as directed by the Engineer. After the correction is made, subsequent tests shall

be performed until the equipment is proven to fulfill the requirements to the entire satisfaction of the Engineer.

## 15.0 REJECTION OF EQUIPMENT

Equipment shall be rejected if:

a) It has a capacity less than required.

b) Its electric motor is overloaded.

c) It causes objectionable noise or vibration.

## 16.0 TESTING AND ADJUSTMENT OF CONTROLS

All controls and instruments shall be operated simultaneously with the equipment or system that they control and tested for proper, accurate and dependable functioning and operation. All controls and instruments shall be calibrated and adjusted to the satisfaction of the Engineer.

## 17.0 GOVERNMENT AND LOCAL AUTHORITIES

Perform at appropriate times during the currency of site work, all tests required by Government and Local Authorities who may from time to time have jurisdiction over the work, and obtain the necessary certificates of approval. Local regulations shall be strictly followed.

## 18.0 DOMESTIC WATER PIPING STERILIZATION AFTER COMMISSIONING

On completion of the potable cold water supply services system, including any parts of the existing service they shall be sterilized by the application of chlorine. The minimum requirements for chlorination shall be to flush the pipework thoroughly to remove dirt. Chlorine shall then be added to the storage tanks and water drawn from all draw-off points until chlorine is detected at each outlet point. The mains are then to be allowed to stand for a period of 24 hours, after which the outlets are to be tested for chlorine. If chlorine is not found to be present, all the above shall be repeated until residual chlorine is detected. After this, the system is to be completely flushed with clean water and precautions taken to avoid subsequent contamination of the installation.

## 19.0 ACOUSTIC DRAINAGE

- The drainage pipework and fittings above suspended ceilings in all kitchen/toilet/ bathroom/corridors and all horizontal pipes shall be of Sound proof material includes all floor traps, pipework fittings, etc.
- All components of the system should be produced by the same manufacturer including the connectors with PVC and floor traps.
- Rubbers used for the push fit fittings should be made of **mol lipped rubbers** for a proper leak protection.
- The soil and waste pipe work shall be manufactured from a sound proofing range.
- The Pipes shall be made of three separate layers (PP-Mineral supplement- PP) with the following properties:
  - Density 1.9g/cm$^3$ according to DIN 53479.
  - Structure born Noise should not be more than 13dB (A) @4l/s according to Fraunhofer Institute.
  - Tensile strength shall be 13N/mm$^2$
  - E-modulus shall be 3800N/mm$^2$
  - Coefficient of thermal expansion equals to 0.04mm/mK.
  - Comply with System Standards of DIN4109 & DIN4102.
- The pipe itself shall be capable of draining off chemically aggressive solid and waste water in ph range of PH2 to PH12.
- Pipe should be able to resist a high temperature up to 95ºC.
- Pipe work shall be self-extinguishing flameless with compliance to DIN 4102, Fire resistance classification B2.
- Connection type: Push-fit with factory inserted lip seals
- Floor Trap shall be water sealed with minimum 75mm as per Dubai Municipality requirements, and should be air-tight, easily accessible for maintenance and should be manufactured from the same material and the same manufacturer.
- The Pipe sizes and wall thickness shall be as per the below table:

| Pipe Size (mm) | Wall Thickness (mm) |
|---|---|
| 58 | 4 |
| 78 | 4.5 |
| 110 | 5.3 |
| 160 | 5.3 |
| 200 | 6.2 |

- The pipe itself shall be capable of draining off chemically aggressive solid and waste water in ph range of PH2 to PH12.
- Pipe should be able to resist a high temperature up to 95ºC.

- Pipe work shall be self-extinguishing flameless with compliance to DIN 4102, Fire resistance classification B2.

- Connection type: Push-fit with factory inserted lip seals
- Floor Trap shall be water sealed with minimum 75mm as per Dubai Municipality requirements, and should be air-tight, easily accessible for maintenance and should be manufactured from the same material and the same manufacturer.

Certificates & standards:

- Franhouver test – Germany
- Test reports according to standards: DIN 4109, 4102, 4100-B2, 1986-100 & 19560 - Germany
- EN 12056 & EN 1451
- Test reports according to standard: VDI 4100 – Germany
- Sound proof/ Acoustic Test – Turkey
- Hoch Fire Test Report – Germany

## 20.0 PPR

- All Polypropylene pipes for cold water supply shall be made of PPR type 3 (polypropylene random copolymer type 3).
- All Polypropylene pipes for hot water supply shall be made of special mixer of fibers integrated in the middle layer of PP-R for more rigid and much less linear expansion in pipework. (Thermal expansion coefficient 0.035mm/mk).
- Boosted cold and hot water pipework from booster pumps from Ground water tank to roof overhead storage tank shall be of Polypropylene PN20 pipe (SDR6).
- Thermal conductivity should not exceed 0.21W/m.°C, Hydraulic Roughness of 0.007mm & Density up to 0.9g/cm3.
- Hot water pipes to be thermally insulated by 19 mm flexible closed cell Elastomeric foam insulation and cladded with 24-gauge aluminum cladding.
- PPR Pipes and fittings should be able to resist an **emergency** operating temperature up to 110°C.
- For cold water application, pipes shall be made of Polypropylene PN-20 manufactured according to DIN 8077 & 8078 and can with stand 25.7 bar @ 20 ºC for 50 years of service.
- Fittings constructed with accordance to requirements of pressure class PN-25, according to the standard DIN 16962.
- For hot water application, pipes shall be made of Faser Composite multi-layer Polypropylene PN-20 (SDR7.4) manufactured according to DIN 8077 & 8078 and can with stand 12.9 bar @ 60 ºC for 50 years of service.
- Pipes and fittings shall be joined by the socket polyfusion method, using a fusion welding machine as per pipe manufacturer’s recommendation as suitable for their piping system.

- Metal inserts for PP-R threaded fittings shall be made of **DVGW approved alloys CW617N (un-plated).**
- PPR elbows with non-centric profiles shall be used, in order to minimize the friction and pressure losses in the network
- Pipes shall be approved for potable water by **DVGW, WRAS & NSF 14, 61**.
- All pipes on roof or outdoor shall be insulated and cladded with Aluminum sheet.
- All installations inside false ceiling, bathrooms or kitchens for internal cold water and hot water distribution pipes shall be Polypropylene including supply to **PEX system**.

Certificates & standards:

- SKZ Test Report- Germany
- DVGW Certificates – Germany
- NSF – US
- WRAS - UK
- PZH Hygienic certificate – Poland
- TZW – Germany
- INSTAL – Poland
- AENOR – Spain
- PN-EN ISO 9001: 2009
- PN-EN ISO 14001: 2005
- Test certificates according to the standards: DIN 8077, 8078 & 16962
- DCL (Dubai Central Laboratory)

**– End of Section –**

## 21.0 VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

**PART 1 –** GENERAL

1.1 REFER TO SECTION 23 05 48

**PART 2 –** GENERAL

2.1 REFER TO SECTION 23 05 48

2.1 PERFORMANCE REQUIREMENTS

A. General:

1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.

2. Steel springs to function without undue stress or overloading.
3. Steel springs to operate in the linear portion of the load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
4. Lateral to vertical stiffness ratio to not exceed 0.08 with spring deflection at minimum 75 percent of specified deflection.
5. All equipment mounted on vibration isolated bases to have minimum operating clearance of 50 mm (2 inches) between the base and floor or support beneath unless noted otherwise.

2.2 EQUIPMENT SUPPORT BASES

A. Structural Bases:

1. Construction: Engineered, structural steel frames with welded brackets for side mounting of the isolators.
2. Frames: Square, rectangular or T-shaped.
3. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snobbier.

B. Concrete Inertia Bases:

1. Construction: Engineered, steel forms, with integrated isolator brackets and anchor bolts, welded or tied reinforcing bars running both ways in a single layer.
2. Size: 152 mm (6 inches) minimum depth and sized to accommodate elbow supports.
3. Mass: Minimum of 1.5 times weight of isolated equipment.
4. Connecting Point: Reinforced to connect isolators and snobbier to base including template and fastening devices for equipment.
5. Concrete: Filled on site with minimum 20 ml. Pa (3000 psi) concrete. See Section 03 3000 for additional requirements.

2.3 VIBRATION ISOLATORS

A. Non-Seismic Type:

1. All Elastomeric-Fiber Glass Pads:
   a. Configuration: Flat or molded.
   b. Thickness: 6 mm (0.25 inch) minimum.
   c. Assembly: Single or multiple layers using bonded, galvanized sheet metal separation plate between each layer with load plate providing evenly distributed load over pad surface.

1) Elastomeric Mounts:

(a) Material: Oil, ozone, and oxidant resistant compounds.

(b) Assembly: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.

2) Steel Springs:

(a) Assembly: Freestanding, laterally stable without housing.

(b) Leveling Device: Rigidly connected to equipment or frame.

3) Restrained Steel Springs:

(a) Housing: Rigid blocking during rigging prevents equipment installed and operating height from changing during temporary weight reduction.

(b) Equipment Wind Loading: Adequate means for fastening isolator top to equipment and isolator base plate to supporting structure.

4) Elastomeric Hangers:

(a) Housing: Steel construction containing elastomeric isolation element to prevent rod contact with housing and short-circuiting of isolating function.

(b) Incorporate steel load distribution plate sandwiching elastomeric element to housing.

5) Spring Hanger:

(a) Housing: Steel construction containing stable steel spring and integral elastomeric element preventing metal to metal contact. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.

7) Combination Elastomeric-Spring Hanger:

(a) Housing: Steel construction containing stable steel spring with elastomeric element in series isolating upper connection of hanger box to building structure.

(b) Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.

8) Thrust Restraints:

(a) Housing: Steel construction containing stable steel spring and integral elastomeric element installed in pairs to resist air pressure thrusts.

(b) Bottom Openings: Sized to allow plus/minus 15 degrees rod misalignment.

2. Seismic Type:

a. Coil Springs Consisting of Single Elements:

1) Housing: Manufactured from cast iron material.

2) Ductile Material: Designed and rated for seismic applications.

3) Spring: Restrained by housing without significant degradation of vibration isolation capabilities during normal equipment operating conditions.

4) Resilient Snubbing Grommet System: Incorporated and designed with clearances of no more than 6 mm (0.25 inch) in any direction preventing direct metal-to-metal contact between supported member and fixed restraint housing.

5) Resilient Pad: Located in series with spring.

6) Coil Springs: Color coded elements to have a lateral stiffness greater than 0.8 times the rated vertical stiffness with 50 percent overload capacity.

7) Finish: Suitable for the application.

8) All Directional Elastomeric:

(a) Material: Molded from oil, ozone, and oxidant resistant compounds.

(b) Operating Parameters: Designed to operate within the isolator strain limits providing maximum performance and service life.

(c) Attachment Method: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.

(d) Rating: Cast iron and aluminum housings rated for seismic restraint applications.

(e) Minimum Operating Static Deflections: Deflections indicated in project documents are not to exceed published load capacities.

2.4 SEISMIC SNUBBER ASSEMBLIES

A. Comply with:

1. ASHRAE Handbook -HVAC Applications
2. SMACNA (SRM)
3. ASHRAE Practical Guide to Seismic Restraint
4. All Directional External:

a. Application: Minimum three (3) snobbier are required for each equipment installation, oriented properly to restrain isolated equipment in all directions.

b. Construction: Interlocking steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.

c. Performance: Equipment movement at each snobbier location limited to a maximum of 6 mm (0.25 inches) in any direction without significantly

degrading the vibration isolation capability of the isolator during normal operating conditions.

d. Resilient Pad: Minimum 6 mm (0.25 inch) thick cushions any impact and prevents metal-to-metal contact.

5. Lateral External:

a. Application: Minimum three (3) snobbier are required for each stable equipment installation, oriented properly to restrain isolated equipment in all lateral directions where uplift forces are zero or addressed by other restraints.

b. Construction: Steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.

c. Performance: Equipment movement at each snobbier location limited to a maximum of 6 mm (0.25 inches) in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.

d. Resilient Pad: Minimum 6 mm (0.25 inch) thick cushions any impact and prevents metal-to-metal contact.

6. Omni Directional External:

a. Application: Minimum four (4) snobbier are required for each stable equipment installation, oriented properly to restrain isolated equipment in all lateral directions.

b. Construction: Steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.

c. Performance: Equipment movement at each snobbier location limited to a maximum of 6 mm (0.25 inches) in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.

d. Resilient Pad: Minimum 6 mm (0.25 inch) thick cushions any impact and prevents metal-to-metal contact.

7. Horizontal Single Axis External:

a. Application: Minimum four (4) snobbier are required for each stable equipment

installation, oriented properly to restrain isolated equipment in all lateral directions where uplift forces are zero or addressed by other restraints.

b. Construction: Steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.

c. Performance: Equipment movement at each snobbier location limited to a maximum of 6 mm (0.25 inches) in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.

d. Resilient Pad: Minimum 6 mm (0.25 inch) thick cushions any impact and prevents metal-to-metal contact.

2.5 SEISMIC RESTRAINTS FOR SUSPENDED COMPONENTS AND EQUIPMENT

A. Comply with:

1. ASHRAE Handbook -HVAC Applications
2. SMACNA (SRM)
3. ASHRAE Practical Guide to Seismic Restraint

B. Cable Restraints:

1. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all directional restraint. Cables must be pre-stretched to achieve a certified minimum modulus of elasticity.
2. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
3. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval AOPA@ Number from OSHPD in the State of California verifying the maximum certified load ratings.

C. Rigid Restraints:

1. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval AOPA@ number from OSHPD in the state of California verifying the maximum certified load ratings.

2.6 ROOF CURBS

A. Vibration Isolation Curbs:

1. Non-Seismic Curb Rail:

a. Location: Between existing roof curb and rooftop equipment.

b. Construction: Aluminum.

c. Integral vibration isolation to conform to requirements of this section.
d. Weather exposed components consist of corrosion resistant materials.

1) Non-Seismic Curb:

(a) Location: Between structure and rooftop equipment.

(b) Construction: Aluminum.

(c) Integral vibration isolation to conform to requirements of this section.

(d) Weather exposed components consist of corrosion resistant materials.

2) Seismic Curb:

(a) Location: Between structure and rooftop equipment.

(b) Construction: Steel.

(c) Integral vibration isolation to conform to requirements of this section.

(d) Snobbier consist of minimum 6 mm (0.25 inch) thick resilient pads to avoid metal-to-metal contact without compromising vibration isolating capabilities.

(e) Weather exposed components consist of corrosion resistant materials.

2. Seismic Type Non-Isolated Curb and Fabricated Equipment Piers:

a. Location: Between structure and rooftop equipment.

b. Construction: Steel.

c. Weather exposed components consist of corrosion resistant materials.

2.7 PIPE RISERS

A. PIPE ANCHORS

1. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 diameter neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm2) and the design shall be balanced for equal resistance in any direction.

B. PIPE GUIDES

Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing 2.8 separated by a minimum 1/2" (12mm) thickness of 60 diameter neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and raiser table to allow for selection of pipe movement. Guides shall be capable of "1 5/8" (41mm) motion, or to meet location requirements

## 22.0 MANHOLE COVERS AND FRAME

A. General:

All covers shall be ductile iron with black bitumen coating. Manhole covers shall have clear opening of 600 x 600 mm. All manholes and gully traps shall be vented as per drainage department requirements. Gully trap covers shall have clear opening of 300 x 300 mm. All manhole covers and frames shall comply with BS 497:1976 part 1.

B. Internal Manholes:

All internal manhole covers shall be bolt down air tight double seal recessed type with brass trim, they shall be insitu concrete filled with surface finish to match surrounding floor. Covers shall be medium duty, locking and sealed.

C. External Manholes:

Covers in paved areas shall be medium duty, double seal, recessed type. They shall be insitu concrete/pavement filled with surface finish to match surrounding floor. Covers subject to vehicular traffic shall be kite marked heavy duty, single seal, non-rock with square push fit seal plate complete with lifting key-holes.

D. INSTALLATION OF MANHOLE ACCESSORIES

Frame of manhole cover shall not be cast in together with roof slab of manhole. Covers and frames shall be fixed in such a way as to match adjacent surface levels with tolerances not exceeding + or - 3 mm. Before the maintenance period expires, check all manhole covers and readjust them if they are in excess of above-mentioned tolerances. Fix all cast iron accessories to concrete manholes using cement and sand mortar (1:3).

## 23.0 FLOOR DRAIN COVERS

Floor drains shall have UPVC traps of minimum water seal of 7cm, and be provided with adjustable and removable strainers. The open area of strainer shall be at least two thirds of the cross-sectional area of the drain line to which it connects.

Floor drains shall have brass, chrome plated or complete heavy-duty stainless steel SS304 with 20 years warranty floor plates with mirror finish connected to the u-PVC trap, with a

removable strainer and cover plate. Floor drains shall have a built-in rodding eye to engineer's acceptance and approval.

**23.1 Roof drain/Rain water outlet RWO**

Roof drain and open to sky drains shall be Ductile Iron type- heavy Duty type connected to the rain water pipe without any trap. Size of drain is 100 mm dia outlet or as shown in drawings, whichever is higher.

**– End of Section –**

**24.0 GRP STORAGE TANKS**

**PART 1 – GENERAL**

1.1 REFERENCE

Conform to General Requirements for Mechanical Services of Division.

1.2 DESCRIPTION OF WORK

Furnish and install Water Storage Tanks as indicated on drawings.

1.3 QUALITY ASSURANCE

a) The manufacture and design of hot press moulded GRP sectional water storage tank shall be to the quality standard requirements of BS EN ISO 9001 and shall comply with the superseded version of BS 7491-3 1994 glass fibre reinforced plastic cistern for cold water storage

b) Manufacturer's Qualifications: Firms regularly engaged in manufacture of specified items with characteristics, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Certification, test certificates under specified operating conditions shall be provided by manufacturer.

c) Certificate of WRC approval shall be provided

1.4 SUBMITTALS:

Product Data: Submit manufacturer's specifications and installation instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of

components. Maintenance Data: Submit maintenance data and parts lists for each type of equipment, control and accessory, including "trouble - shooting" maintenance guide. Include this data, product data and shop drawings in maintenance manual.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

Handle equipment and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged equipment or components, replace with new. Store equipment and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

**PART 2 - PRODUCTS**

2.1 APPROVED MANUFACTURERS

2.1.1 Refer to approved manufacturers list in the Appendix.

2.2 WATER TANKS

2.2.1 Tanks shall be supplied with internal division plates, central where sizes permit, to create two independent equal compartments for maintenance purposes. The internal division plates are to be adequately braced to enable drain down of one compartment whilst the other compartment remains operational.

2.2.2 The separate compartments of the tank shall be provided with an interconnecting valve pipe manifold from which the various distribution services shall be taken.

2.2.3 Each compartment shall be provided with a connection for draining down the contents of the tank, which shall be provided with a lock shield pattern valve and shall be piped to a convenient discharge point on a drainage system to discharge in open air at least 150 mm above the discharge point.

2.2.4 Each compartment shall be provided with an overflow of the appropriate size to carry away all water discharged to the tank in the event of the inlet control device, i.e. float operated valve becoming defective, without the inlet control device becoming submerged. In addition, a warning pipe of not less than 28 mm diameter shall be provided at least 50 mm below the lowest point of the overflow where tanks exceed 1,000 liters.

2.2.5 For tanks exceeding 10,000 liters a device may be fitted to give audible or visual alarm in substitution for a warning pipe as detailed in the Project Specification.

2.2.6 Overflow and warning pipes shall be piped independently to a discharge point on a drainage system to discharge in open air at least 150 mm above the discharge point. Pipes discharging to a common point shall be labeled such as to identify the source

of the discharge.

2.2.7 All overflows and warning pipes shall be labeled throughout their length and fitted with screens to prevent the ingress of insects and vermin. The device shall be fitted with a corrosion resistant mesh of maximum perforations of 0.65 mm diameter and still maintain the cross-sectional area of full overflow or warning pipe.

2.2.8 Each compartment shall be provided with an air inlet ventilator fitted with a corrosion resistant mesh screen having maximum perforations of 0.65 mm diameter to prevent the ingress of insects and vermin.

2.2.10 Each compartment shall be provided with access covers hinged and lockable ABS lid, suitablysized for the maintenance of the float operated valve.

2.2.11 Each compartment shall be provided with access covers hinged and lockable ABS lid in a secure manner, suitably sized 600 X 600 mm for man access to enable interior inspection and cleansing of the tank. All tanks shall be provided with internal ladders constructed from GRPwhere man entry is required for tanks 1.2 meters or more in depth.

2.2.12 Tank covers shall be heavy duty flat covers bolted down constructed from materials which will not contaminate any water which may condense on its underside.

2.2.13 Galvanized mild steel or aluminum ladders constructed in accordance with BS 4211: l987 shall be provided to the tank for easy access to float operated valve positions.

2.2.14 The entire tank shall be insulated against heat and frost in accordance with this Specification.

2.2.15 Insulation shall be at least 40mm thick of expanded polystyrene, density grade 30 or polyurethane foam 25mm thick 40kg per cubic meter insulation material. Insulation shall notbe exposed to external weather condition

2.3 GLASS REINFORCED PLASTIC SECTIONAL:

2.3.1 Tanks shall be constructed from hot press moldings of glass reinforced plastic fromstandard 1.0 m x 1.0 m, half plates 1.0 m x 0.5 m and corner angles.

The panels shall be manufactured by hot tool molding at a temperature of 140 C at 1.7 barusing chopped BS 3691 'E' glass roving's and BS 3496 continuous filament 'E' glass matt, UV stabilized BS 3532 unsaturated iso-plethoric modified polyester resin, calcium carbonate fillerand a D-tertiary butyl peroxyl trimethyl cyclohexane catalyst with pigment coloring.

2.3.2 The panels shall be assembled and bolted together with 12 mm stainless steel nuts and bolts conforming to type 316/A4 in accordance with BS 6105 and shall be provided with flat washers to bolt head and nut.

2.3.3 All water tanks shall be externally flanged.

2.3.4 The manufacturers sealant strip shall be laid between each joint and shall be non-

toxic and prohibitive to the support of bacteriological or fungous growth.

2.3.5 G.R.P. Tanks (Particular Specifications)

The Contractor shall supply and assemble at Site sectional water tank of hot-pressed molded GRP insulated panels (Glass Reinforced Plastic) of ivory or grey color provide with lockable manhole cover air vent with overflow and all piping connections. The panels shall comply with BS 7491: Part 3: 1994 and shall have convex shape to assist a complete draining of water of the following

characteristics: -

(a) Specific gravity of 1.8
(b) Tensile strength of not less than 850 kg/cm2
(c) Flexural strength of 1800 kg/cm2 to ISO 178.
(d) Impact strength of 80 kg/cm2 to ISO 179
(e) Thermal expansion of 2.1 x 10-5 deg. C to ATM D 696.
(f) Thermal conductivity of 0.6 W/m2 C to BS 7491: Part 3.
(g) Water absorption less than 0.2% to ISO 62.
(h) Glass content more than 30%
(i) No light transmission
(j) Gasket of synthetic rubber
(k) Bolts and nuts of stainless steel 316 / A4.
(l) Frame angles and frame plates of hot dipped galvanized steel.
(m) External ladder of hot dipped galvanized steel.
(n) Internal ladder of GRP or S.S. according to Manufacturer's standards.
(o) Tie rods of stainless steel
(p) G.R.P. panel thick not less than 8mm
(q) Resin cover of 2mm
(a) Glass tube level indicator for all compartments.
(b) Insulation 25mm.

PART 3 - EXECUTION

3.1 <u>WORKSHOP DRAWINGS:</u>

3.1.1 The Contractor shall be responsible for ensuring accurate detailed construction drawings are produced. The drawings shall illustrate the size, location and type of all connections required, details of float operated valve fixings, location and provision of access covers, vents, etc. together with the detailed requirements and Specification for the base support system.

3.1.2 The workshop drawings shall be issued to the CA/Engineer for review to ensure the Employers requirements have been met in full.

3.1.3 The issue of the drawings for review shall be well in advance of any works to be carried out on site for the preparation of the Builders work requirements of the tank and shall be issued sufficient to allow the CA/Engineer fourteen (14) days from

receipt to comment.

3.2 CONNECTIONS TO COLD WATER STORAGE TANKS:

3.2.1 Connections to GRP and concrete water tanks shall be carried out strictly in accordance with the manufacturer's recommendations using materials and components supplied by the manufacturer and shall in all cases be two-piece PVC flange connections with mastic seal andsecured with stainless steel nuts and bolts conforming to type 316/A4 in accordance with BS6105.

3.2.2 All such types of tank connections shall be provided with pipe support immediately after the assembly to ensure no load is transmitted directly to the connection assembly.

3.2.3 Connections to steel manufactured tanks shall be factory fixed prior to dispatch and shall betapped flanges for screwed pipe work up to and including 50 mm pipe work and pads with studs for flanged pipe work 75 mm and above.

3.2.4 Builders work:

3.2.5 All materials and works associated with the provision of the tank base or support on which the tank will be erected shall be supplied and executed by the Contractor in accordance withworkshop drawings produced by the tank manufacturer.

3.2.6 The Contractor shall neither procure materials nor execute the works until such time as theCA/Engineer has completed the review of the workshop drawings.

3.2.7 The Contractor shall adhere strictly to the specific requirements as required by the particular tank manufacturer shall conform to the following minimum requirements.

3.3 SOLID CONCRETE PLINTHS:

3.3.1 Solid concrete plinths shall be structurally designed to support the weight of the tank, including the contents, and shall consider the ground bearing conditions or load limitations of the floor constructions.

3.3.2 Plinths shall be a minimum of 150 mm high and in length and breadth 300 mm longer than the tank overall dimensions including flanges so as to create a plinth 150 mm larger aroundthe extremities of the tank. The top surface of the plinth shall be smooth and level to within2 mm laterally or diagonally across the extremities of the tank, without any abrupt changesin level.

3.4 DWARF WALLS:

3.4.1 Dwarf walls shall be constructed from engineering bricks or reinforced concrete to a minimum width of 200 mm. The walls shall be constructed at 500 mm centers arranged as required to length or breadth of the tank and shall exceed the overall dimensions of the tankby 150 mm at each end.

3.4.2 The walls shall be structurally designed to support the weight of the tank including the contents and shall consider the ground bearing conditions or load limitations of thefloor construction.

3.4.3 The tolerances applicable to the level of the walls shall be 2 mm across the length of the wall and between walls farthest from each other as well as diametrically

across the walls.

3.5 STEELWORK:

3.5.1 Where steelwork mill rolled sections are to be provided the sections are to be located at 500mm centers arranged as required to length or breadth of the tank and shall exceed the overall dimensions of the tank by 150 mm at each end.

3.5.2 The steel sections shall be selected to be structurally suitable to support the weight of the tank including the nominal contents considering the ground bearing conditions or load limitations of the floor construction.

3.5.3 The maximum permissible deflection of the steel section shall not exceed 1/ 500th of the unsupported span.

3.5.4 The tolerance applicable to the level of the steel sections shall be 2mm across the length of the wall and between sections farthest from each other as well as diametrically across the sections.

3.6 ERECTION AND COMMISSIONING:

3.6.1 The erection of the tanks upon plinths, dwarf walls or steel constructed by the Contractor shall be carried out by the tank manufacturer.

3.6.2 The tank manufacturer shall ensure that the plinths, dwarf walls or steel supports for tank are strictly in accordance with the agreed installation/ workshop drawings and that all construction tolerances meet with his requirements and the requirements of this Specification, before commencement of the erection of the tank.

3.6.3 The Contractor shall attend all times to ensure sufficient access, lighting and power is available for the Works and that activities by the tank erectors does not impede other site activities and also that the highest standard of workmanship is maintained at all times.

3.6.4 Upon completion, the erected tank is to be offered for inspection by the CA/ Engineer priorto any further works being carried out.

3.6.5 After acceptable inspection by the CA/Engineer the tank may be filled with clean, fresh mains water to determine water tightness of the installation. The water tightness testing ofthe tank shall be continuous for 24 hours during which time the Contractor shall be in constant attendance to action any failure of joints which may occur during this period.

3.6.6 A certificate shall be issued by the Contractor to the CA/Engineer to confirm satisfactory completion of the test. The test certificates shall be included in the Record Documents.

3.6.7 Where tanks are required to be insulated, execution of the insulation works shall not be carried out until satisfactory water tightness of the tank has been achieved.

3.6.8 Sterilization procedures to be adhered to for the commissioning of the storage tank shall bein accordance with this Specification.

**END OF SECTION**

# SECTION 04

# SOIL, WASTE, VENT & STORM WATER SYSTEMS

**SECTION - 04**

**SOIL, WASTE, VENT & STORM WATER SYSTEMS**

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## 1.0 SCOPE OF WORK

1.1 The work shall include design check, supply, installation, commissioning, adjustment and setting to work of the drainage installation.

1.2 By virtue of carrying out a check on the complete design, the contractor is to assume full responsibility for the correct functioning of the system and to carry any liability or guarantee as may be necessary to protect all parties in this regard.

1.3 The drainage services subcontractor shall be responsible for the coordination with other trades and services and shall provide all materials, labour and supervision, equipment, tools, appliances, services etc., for carrying out the following items of work:

- Soil and Waste drainage systems
- Storm water drainage systems
- Identification of all services
    - All builder's work including breaking and making good of walls, floors etc., equipment foundation pads, sleeves etc.

## 2.0 SYSTEM DESCRIPTION:

2.1 System Design

This shall be a gravity drainage system designed in accordance with the recommendations of the Chartered Institution of Building Services Engineers and to the requirements of the Local Drainage department whichever is more stringent.

2.2 System Description

Sewer Drainage Network

The system shall be DOUBLE stack together with vent installation. All work shall be installed and tested in accordance with BS 5572 code of practice for sanitary works.

2.2.1 Surface water drainage network

Rain water from the roof shall be piped down via separate pipe work to connect as shown on drawing.

2.2.2 Rain water from the balconies shall be piped down and connected to waste pipes through running traps.

2.2.3 Rain water shall be free discharge at ground floor.

2.2.4 Condensate drain from Air conditioning equipment shall be connected to nearest floor drain or to waste stack through U-trap. Contractor to coordinate with A/C layouts for each location.

**INTERNAL DRAINAGE**

**3.0 INSTALLATION**

3.1 Vent pipes shall extend through roof and terminate 600 mm above it with vent cowl. Vent pipes passage through the roof shall be made watertight by proper flashing.

3.2 All changes of direction shall be gradual and not abrupt, 45-degree fittings shall be used wherever possible, and 90-degree fittings shall be of the long-sweep type. All unnecessary turns and off sets shall be carefully avoided, and run as directly as possible from the sanitary fixtures to the vertical stacks.

3.3 Concealed pipes shall be installed in such a manner as to permit easy accessibility for maintenance, this applies particularly to valve locations.

3.4 All pipes shall be fixed in neatly arranged lines, and adequately pitched horizontal lines to allow the system to be properly vented and drained. Air pockets, traps and sags shall be carefully avoided.

3.5 Supports, clamps and hangers shall be made of galvanized steel with rubber internal rubber seal, fixed with drilled plugs. Cutting and pinning of fixings will not be permitted.

3.6 Run building drains at a minimum grade of 1 % (1:100) pitch unless otherwise noted, downward in the direction of flow. Pitch brand connections to stacks from fixtures at 2 % (1:50) where possible.

3.7 Provide all the required appurtenances to make drainage system complete in compliance with code requirements including traps, pipe fittings, hangers and the like.

3.8 Wherever possible, vent stack offsets shall be made with 45-degree fittings.

3.9 Take special care in setting roof drains to ensure that they are set an elevation which will prelude formation of puddles.

3.10 Install connections to roof drains in conjunction with the roofing specified under civil works, so that the building is adequately protected during construction from damage by storm water.

3.11 No short radius bends to be used. Use short “Tee-Wye” fittings in vertical piping only.

3.12 Any piping passing through roofs shall be so arranged to be a minimum of 300 mm (1 ft.) from walls or other obstructions so as to permit proper flashings which are provided by another trade.

3.13 Horizontally long running soil & waste shall be vented from the top end, whether shown on drawing or not.

## 4.0 CLEANOUTS ON SOIL, WASTE, VENT AND STORM WATER INSTALLATION

4.1 Cleanouts shall be installed at each change of direction of drainage pipes, greater than 45 degrees, inside the building, and where indicated on the drawings. Cleanouts shall be not more than 10m apart in horizontal lines. A cleanout shall be provided at or near the foot of each vertical waste or soil stack.

4.2 Cleanouts on concealed piping shall be extended through and terminate flush with finished wall or floor. Pits or chases may be left in the wall or floor, provided they are of sufficient size to permit removal of cleanout plug and proper cleaning of the system.

4.3 Where it is necessary to conceal a cleanout plug, a heavy-duty covering plate shall be provided, which will permit ready access to the plug.

4.4 Cleanout plugs shall be of heavy duty with seal and lock. Final finish shall be to the approval of the Architect.

4.5 Cleanouts shall be of the same nominal size as the pipes up to 100mm pipe diameter and not less than 100mm for larger piping.

4.6 Cleanouts shall be so installed that there is a clearance of not less than 45 cm for the purpose of rodding and cleaning.

4.7 Provide cleanouts at root of all stacks, changes of directions, at the ends of the branch runs, in straight runs as required and where indicated. Terminate as specified under “Cleanouts”.

**MATERIAL**

- Unless otherwise indicated on drainage, vent and rain water pipes and fittings inside the building shall be of uPVC to BS 4514 for pipe sizes upto 80mm dia and MuPVC/ABS to BS 5255 for pipe sizes up to 50mm dia and smaller.
- Sound proof pipes to be provided for all pipes except vent pipes running above false ceiling

- Drainage pipes buried under ground up to manhole shall be uPVC to BS 4660.
- Sewage pipe between manholes shall be uPVC BS 4660 protected with concrete encasement.
- Pumped drainage pipes shall be HDPE with welded joints.
- All pipes under building and those subjected to traffic especially under roads shall be protected with reinforced concrete.

## 5.0 SPECIFICATION FOR UPVC SOIL & WASTE DRAINAGE SYSTEM

UPVC Soil systems shall be grey colour and comply to BSEN 1329: 2000 with all pipe and fittings manufactured within a BS EN ISO 9001 quality system. All fittings shall either bear the British Standard Kitemark or have a BBA agreement certificate where appropriate.

All soil pipes and fittings in sizes 200mm 160mm, 110mm and 82mm shall be made from UPVC and have ring seal joints to allow for system expansion. All soil pipe sizes shall be properly sized in relation to discharge units from bathroom and kitchen appliances / sanitaryware. Refer to manufacturer for assistance.

Where a pipe passes through a sound-sensitive wall, ceiling or floor slab, a sound proof pipes shall be used in the ceiling. All above ground soil, waste and rain water pipes in the building which is running inside the flats shall be sound proof drainage pipes and fittings made of mineral-reinforced polypropylene homopolymer and copolymer. The typical density of the mineral filler shall be 2.7 g/cm3 for pipes and fittings.

The sound isolation shall be 20 DB for 4.0 l/s flow rate in accordance with DIN EN 14366 and DIN 4109. The sound proof pipes & fittings shall be fire resistant class B2 to DIN 4102. The sound proof pipes & fittings shall be fungus and bacteria resistant, and shall have smooth surface, corrosion resistant.

Soundproof drainage pipe system shall comply with following standards:

DIN 4109m sound proof, absorption standards.

- DIN 4102, B2. Self-extinguishing flameless.

- DIN 19560 / DIN EN 1451. Hot water resistance, 90°C (Long term), 90°C (short term).

- Physical characteristics

Mineral Filler Density - 2.7 g/cm³ DIN 53479

Elongation at break - 50%

Tensile strength - 20N / mm²

E-modulus - 3800 N / mm² for 1 Layer and 1500 N/ mm² for 3 Layer

Linear expansion - 0.09 mm / mk

Drainage pipe work inside building shall be made of sound proof piping system made from mineral supplemented polypropylene. The pipes should consist of three layers (polypropylene-mineral additives-polypropylene) with a sound insulation layer, density should not be less than 1.9gr/cm3 for soil and waste, or one thick layer pipe made of mineral-reinforced polypropylene.

2.5.6 The sound proof pipes and fittings shall be self extinguishing flameless for the fire behavior and complies with DIN 4102, B2.

All waste pipes and fittings, white or grey colour, in sizes 50, 40 & 32mm shall be high temperature resistant and manufactured from either uPVC, MUPVC or ABS. Joints shall be solvent weld and comply to either BSEN 1329 (uPVC), BS5255 (MUPVC) or BSEN1455 (ABS).

Floor traps in false ceiling should have a minimum water seal of 75mm and the fitting shall be supplied with a loose base so that the body height can be adjusted for casting in a shallow slab. Accompanying tile grates and covers shall be stainless steel grade 304.

## 6.0 SPECIFICATION FOR UPVC UNDERGROUND DRAINAGE SYSTEM

UPVC underground drainage systems shall be orange colour and comply to BSEN 1401: 1998 with all pipe and fittings manufactured within a BS EN ISO 9001 quality system. All fittings shall either bear the British Standard Kitemark where appropriate.

Inspection chambers shall be made from polypropylene and comply to BS7158: 2001.

## 7.0 SPECIFICATION FOR HDPE

Material
To be made from black High-Density Polyethylene (HDPE) grade PE80, colored in with 2% of carbon for UV resistance with a density between 0,94 and 0,97 g/cm3.

Dimensions
DN 40 to DN 315 (some fittings in DN 32 connection).

Standards
Pipes, fittings and system to be manufactured conform with the requirements of EN1519-1:2000 “Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Polyethylene (PE) Specifications for pipes, fittings and the system”.

TENDER SPECIFICATION TEXT

## 8.0 SPECIFICATION FOR ACOUSTIC SOIL & WASTE SYSTEM

Material

Blue, similar to RAL 5012.

Pipes to be made of 3-layers of polypropylene:

1. Inner layer made of abrasion-resistant and smooth Polypropylene (PP) to prevent incrustation
2. Middle layer made of highly rigid and sound absorbing mineral-reinforced Polypropylene (PP-MD) should have a minimum density of 1.2 g/cm³
3. Outer layer made of impact resistance and shock-proof Polypropylene (PP)

Fittings to be made of mineral-reinforced Polypropylene (PP-MD) with factory installed SBR rubber ring.

Flour trap (110/3x50/75mm) should be from the same manufacturer and should be made of mineral-reinforced Polypropylene (PP-MD).

Standards

Pipes, fittings and system to be manufactured conform with the requirements of EN1451-1:1999 “Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Polypropylene (PP) - Part 1: Specifications for pipes, fittings and the system”.

Furthermore, the products should meet the standards EN1411, EN14366, EN13501, DIN4012, EN1055, EN1054 and EN681. Floor Waste Gully (110/3x50/75mm) to be manufactured conform with the requirements of EN1253.

Sound insulation

For the vertical installation: Test results in accordance with EN14366 for structure borne noise level should be below 20 dB(A) at 4L/S for 110mm pipes and fittings.

For the horizontal installation: The system should be tested according to the established acoustic industry test ISO 140 and independently rated to ISO 717. This test is carried out and meets the required Rw + Ctr 25 and 40 benchmarks without the need for lagging.

Approvals

Pipes, fittings and system should have the following approvals:

- Germany : DIBt : Z-42.1-399 (Germany institute of building technology)
- Australia : Watermark

- Poland : ITB
- Sweden : SCB (KIWA)

Quality : Pipes, fittings and system should be manufactured in an environment which operates a Quality Assurance System assessed to ISO 9001.
Chemical Resistance: System should have safe pH values range from 2 to 12.

Temperature Resistance: system should have temperatures resistance up to 95ºC (brief load) and 90 ºC (continuous load).

Fire protection: System shall be normally inflammable rated class B2 according to DIN 4102.

**9.0 FLOOR / ROOF / BALCONY DRAINS**

9.1 Floor drains unless otherwise indicated shall have uPVC traps of a minimum water seal of 7 cm, and shall be provided with adjustable and removable strainers. The open area of the strainer shall be at least two thirds of the cross-sectional area of the drain line to which it connects. Floor drains shall have SS316 with a removable strainer and cover plate. Floor drain shall have built in rodding eye.

All floor drains / cleanouts must be coordinated with floor tiling layout.

9.2 Roof rain water outlet shall be domed uPVC body with UV protection.

9.3 Balcony outlet shall be of heavy-duty stainless steel with trapped or non-trapped sump. Cover to be chrome plated brass.

**EXTERNAL DRAINAGE**

**10.0 GENERAL REQUIREMENTS**

10.1 Pipe connections to manholes shall be made in a completely watertight and approved manner.

10.2 Pipes shall be kept clean until final acceptance of the work. Exposed ends of all incomplete lines shall be closed with wooden plugs and adequately secured at all times when pipe laying is not actually in progress.

10.3 Pipes shall not be buried at less than 60 cm below finished grade for protection against mechanical damage. Pipes shall not be run closer than 1m to building bearing walls and footings for protection against building settlement.

10.4 All pipes shall be laid to a uniform slope. Slopes of sewer drain shall be limited to 3% maximum. The free vertical drop of a sewer pipe into a manhole shall be limited to 45cm between the invert level of the pipe opening and the bottom of the manhole. Where conditions necessitate that the drop would exceed 45cm at the maximum slope of 3% a drop manhole shall be used.

10.5 All pipe joints to be push fit type.

10.6 Precautions shall be taken to protect incomplete work from floating due to storms or from any other cause. All pipe lines or structures not stable against uplift during construction shall be well braced or otherwise protected.

10.7 All completed underground lines shall be subject to the inspection and approval of the Engineer. All pipes shall be true to line and grade. The full circle of the pipe shall be visible at the manholes.

**11.0 INSTALLATION**

11.1 The drains shall be laid truly straight in line and to an even gradient.

11.2 Excavations shall be made true and even to falls. The bottoms being trimmed to correct level and well rammed. Remove mud, rock projections, boulders and hard spots and replace with approved fill material well consolidated.

11.3 Minimum width of trench shall be 300mm greater than external diameter of pipe.

11.4 Any trenches excavated in error to a greater depth than required shall be in-filled back to the required level with concrete mix, at the Contractor's expense.

11.5 Before laying, all pipes and components shall be checked for defects and joint spaces cleared of dirt.

11.6 Socketed pipes to be laid with sockets uphill.

11.7 Flexible joints shall be made in strict accordance with manufacturer's instructions.

11.8 Where lubrication of the joints is required, the pipe manufacturer's recommended lubricant shall only be used.

11.9 Spigot and socket cement joints where required shall be made with ring of tarred gasket well caulked in socket and remaining socket space filled with 1:3 cement mortar, finished in 45 deg. fillet.

11.10 Lay and compact bed of granular material to provide 100mm thickness over the full width of the trench. Scoop out locally at pipe sockets where socketed pipes are used. Adjust pipes to line and level and ensure that pipe barrels rest uniformly on the bedding.

11.11 Add granular side fill uniformly up each side of pipes compacting by hand.

11.12 Any trench sheeting should be lifted before the fill is compacted.

11.13 The granular material shall be compacted in 100mm layers by hand upto 100mm minimum distance above top of the pipes.

11.14 During bad weather, or in wet fine-grained soils such as clays, silts or sands, it is important to prevent the trench bottom being churned up by mean working in the trench. In such cases a blanket of granular material 75mm thick laid over the trench bottom immediately after excavation, or alternatively a sealing layer of weak concrete 50mm thick, is required.

11.15 Drain tracks beyond 900mm of adjacent foundations and where the bottom of the trench is lower than a depth beneath the foundation equal to the horizontal distance between the nearside of the trench and the foundation less than 150mm, shall be infilled with concrete upto that depth.

11.16 Concrete bed and surround shall incorporate movement joints at each drain pipe joint.

## 12.0 MANHOLES

12.1 All manholes shall be constructed to the requirements of the Authority regulations.

12.2 Internal manhole covers shall be bolt down alright double seal, recessed top.

12.3 Covers to be insitu concrete filled, with surface finish to match surrounding floor. All covers are to be medium duty, locking and sealed, with a clear opening of 600mmx600mm.

12.4 Covers for external manholes subject to vehicular traffic shall be kite marked, heavy ductile iron single seal and non-rocky heavy duty with square push fit seal plate. Covers to be complete with lifting key-holes, generally constructed in accordance with BS 497:76 and shall have a clear opening of 600x600mm unless otherwise indicated. Double seal covers shall be provided where indicated on drawings.

12.5 All covers shall be of ductile iron and shall be grey epoxy coated.

## 13.0 GULLY GRATES

13.1 Where indicated on drawings, provide kite marked kerb gully unit of ductile iron hinged grate, road retaining bar with clear opening size 532x405mm. Unit to be black bitumen

coated and shall be designed to deter ingress and help prevent blockage. A GRP grid shall be provided as standard.

## 14.0 TESTING OF DRAINAGE AND VENT PIPE SYSTEMS

14.1 Before the sanitary fixtures are installed, drainage and vent pipe systems shall be subjected to a water pressure test to ensure and prove their tightness and to a flow test to ensure their freedom from obstructions.

14.2 The water pressure test shall be applied to the system in its entirety or in sections. All openings in the piping shall be tightly closed with special cast iron pipe plugs or other suitable means and the system filled with water to the point of overflow from the highest opening. The plugs shall be temporarily opened to make sure that all air has been vented and that water has reached all parts of the system.

14.3 The water shall be kept in the system or in the portion under test for at least 4 hours before inspection starts. While the system is under pressure, a careful inspection shall be made of all pipes and joints and if any leaks in joints or evidence of defective pipe or fitting is disclosed, the defective work shall be corrected immediately by replacing defective parts with new joints and materials. No makeshift repairs or application of any repair compound will be permitted.

14.4 After correction is made, the pressure test shall be repeated until the system is proved tight.

14.5 Underground drainage pipes shall be tested by plugging the end of the pipe and filling with water to a minimum head of 3 meters. The test pressure shall be maintained for 24 hours. Pipes and joints shall be inspected and approved before backfilling the trench.

14.6 All drainage systems shall be tested for proper flow to ensure their freedom from any obstruction. The Contractor shall disassemble, clear, repair and re-assemble obstructed piping at his own expense. After re-assembly, the piping shall again be subjected to pressure test.

**– End of Section –**

# SECTION 05

# AIR CONDITIONING & VENTILATION SYSTEM

**SECTION - 05**

**DUCTWORK AND AIRSIDE EQUIPMENT**

**INDEX**

1.0 SCOPE OF WORKS

2.0 DESIGN PARAMETERS

3.0 METER AND GUAGES

4.0 FRESH AIR HANDLING UNITS

5.0 FAN COIL UNITS

6.0 CLOSED LOOP PRESSURIZATION AND MAKE UP WATER SYSTEM DIFFUSERS AND REGISTERS

7.0 AIR SEPERATORS

8.0 CHEMICAL DOSING POT SYSTEM

9.0 CHILLED WATER PUMP

10.0 BTU METER

## 1.0 SCOPE OF WORK

1.1 The works shall include supply, installation, testing, commissioning, balancing and adjustment and setting to work of the following systems:

- DX systems and air-conditioning of all areas
- Ventilation

1.2 Contractor is to assume full responsibility for the correct functioning of the system and to carry any liability or other insurance or guarantee as may be necessary to protect all parties in this regard.

1.3 Contractor shall be responsible for coordination with other trades and services and shall provide all materials, labor and supervision, equipment, tools, appliances, services, etc. for carrying out the following items of work:

- Supply and install brand new air conditioning, ventilation system and equipment Insulated ductwork complete with air terminals, dampers, supports, etc.
- Insulated refrigerant pipework complete with valves, fittings, supports, etc. Controls and control panels.
- Motor control centres and starter panels complete with cabling from the panels to the respective equipment. Power supply upto the panel shall be the responsibility of the electrical subcontractor.
- Power supply to Air conditioning units, fans etc. Electrical power supply terminating in an isolating switch within 2 metres of the equipment shall be the responsibility of the electrical subcontractor.
- Insulated drain piping from each indoor unit to the nearest drain point. The drainage subcontractor shall be responsible for provision of a floor drain in each mechanical room.

1.4 The contractor shall also include all overheads at office and site, labour, sundries, plant, appliances and consumable both for the works and for balancing, testing and commissioning, and during the maintenance period.

## 2.0 DESIGN PARAMETERS

Design, in general, shall be based on ASHRAE recommendations with the following particular requirements:

DESIGN TEMPERATURE CONDITIONS

a) External Summer – 46°C DB, 30°C WB

b) Internal Summer – 24°C DB ± 1°C, 50 ± 5% RH

VENTILATION REQUIREMENTS

As shown on ventilation plans

2.1 NOISE LEVELS

| | | |
|---|---|---|
| Living room | - | NC 35 |
| Bedrooms | - | NC 30 |
| Corridors | - | NC 40 |

Noise level shall be achieved at high speed selection of FCU at maximum airflow.

2.2 AIR DISTRIBUTION

| | | |
|---|---|---|
| Duct Velocity, supply | : | 2.5 (m/s) |

(Pressure drop to be limited to a maximum of 0.6 Palm)

| | | |
|---|---|---|
| Duct velocity, return | : | 2.5 (m/s) |
| Duct velocity, Kitchen exhaust | : | 7.5 (m/s) |

2.3 AIR FILTRATION

Based on ASHRAE Standard 52-76.

2.4 PRESSURIZATION PHILOSOPHY

Fresh air requirements to each zone shall be generally determined by the level of dirty extract to that same zone, or to a value as required for the levels of occupancy in each zone.

Areas requiring no dirty extract shall be positively pressurized or maintained neutral as recommended by ASHRAE.

Areas requiring dirty extract shall be pressurized delta negative.

The whole villa shall be positively pressurized to avoid any hot air infiltration.

2.5 Glazed Elements

Glazed elements – Fenestration performance requirements as per Green Building Regulations & Specifications but not limited to below values:

| | | |
|---|---|---|
| Thermal Transmittance - U | : | 2.1 W/m$^2$K (max) |
| Shading Coefficient | : | 0.40 (max) |
| Light Transmittance | : | 0.25 (min) |

Glazed elements details to be as per Architectural details.

2.6 U values for all building elements to be as per Design (Based on Local Authority regulations).

2.7 AIR INTAKE SYSTEM

Fresh air intake to each indoor unit shall incorporate a sand trap louver and/or in line filter within a sheet metal plenum chamber.

Air intake louvers shall, in general, be located as far away as possible from extract louvers and drainage vent stacks to avoid short circuiting of dirty air.

The condensing unit shall have special design suitable for high ambient climatic conditions.

2.8 CONDENSATE PIPEWORK

Condensate pipework shall be installed in accordance with supplier's Design and Installation Instructions and the unit's installation manual.

POWER CIRCUIT AND CABLE REQUIREMENTS

Control Cable shall be two core flex to BS6500 and 0.75-1.25mm2

Power cable & Size shall be as per IOM manual.

Power circuit shall be fitted with suitable Residual Current operated Circuit breakers (type 300mA).

2.9 COMMISSIONING & TESTING

Commissioning shall be carried out by a factory trained engineer. Qualified manufacturers shall have training academy and is providing direct warranty and not local representatives. Manufacturer shall have service setup that can provide quality service directly and have history of last 10 years.

The entire refrigeration system shall be pressurized with Nitrogen to 38 bar for a period of 24hours as per Manufacturer's recommendations.

Leak testing shall be carried out with a calibrated electronic leak detector, or similar if the system fails to hold pressure within testing period.

Upon completion of pressure test, the pressure shall be released and vacuum pump installed on the system to remove air and moisture from the system. The system shall be evacuated to –101.1kPa (-758mmHg, 2 torr) and held for a period of 2 hrs. With the vacuum pump switched off.

Refrigerant should be charged to the liquid pipe in its liquid state to ensure that the refrigerant composition is assured. The refrigerant charge shall be calculated to the system requirements and in accordance with Supplier's Design and Installation Instruction booklet.

## 3.0 Meters and Gauges

1.1 SUMMARY

A. Section Includes:
1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Duct-thermometer mounting brackets.
6. Thermowells.
7. Dial-type pressure gages.
8. Gage attachments.
9. Test plugs.
10. Test-plug kits.
11. Sight flow indicators.
12. Flowmeters.
13. Thermal-energy meters.

B. Related Requirements:
1. Section 232113 "hydronic piping.
2. Section 232116 "hydronic pipe specialties.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
1. Include diagrams for power, signal, and control wiring.

1 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage from manufacturer.

1 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenancemanuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers and products: as per vendor list.
B. Standard: ASME B40.200.
C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch (127-mm) nominal diameter.
D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F anddeg C.
E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
F. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw thread.
G. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
H. Window: Plain glass
I. Ring: Stainless steel.
J. Element: Bimetal coil.
K. Pointer: Dark-colored metal.
L. Accuracy: Plus or minus 1 percent of scale range.
M. Warranty: Five (5) Years

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Gas-Actuated Thermometers:
1. Manufacturers and products: as per vendor list.
2. Standard: ASME B40.200.
3. Case: Sealed type, Phenolic or drawn steel; 4.5-inch (115-mm) nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection topointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated indeg F and deg C.
7. Pointer: Dark-colored metal.
8. Window: Polycarbonate
9. Ring: Phenolic, bayonet type
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees inhorizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem andof length to suit installation.
a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.
13. Warranty: Five (5) Years.

B. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Manufacturers and products: as per vendor list.
2. Standard: ASME B40.200.
3. Case: Sealed type, Phenolic; 4-1/2-inch (114-mm) nominal diameter with back flange andholes for panel mounting.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: No reflective aluminum with permanently etched scale markings graduated indeg F and deg C.
7. Pointer: Dark-colored metal.
8. Window: Polycarbonate.
9. Ring: Phenolic, Bayonet type.
10. Connector Type(s): Union joint, back; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem andof length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.
13. Warranty: Five (5) years

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Manufacturers and products: as per vendor list.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch (229-mm) nominal size.
4. Case Form: Adjustable angle, $360^0$ in horizontal plane and $180^0$ in vertical plane
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum or brass and of length to suit installation.
    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inch (29 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent
11. Warranty: Five (5) years

2. DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2. THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: Brass
4. Material for Use with Steel Piping: Stainless Steel
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of Thermometer connection.

Heat-Transfer Medium: Mixture of graphite and glycerin.

B.

DIAL-TYPE PRESSURE GAGES

Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

2.

A. 1. Manufacturers and products: as per vendor list.

2. Standard: ASME B40.100.

Case: Liquid-filled Sealed, back pressure relief type(s); Stainless Steel or drawn steel; 4-1/2-inch (114-mm) nominal diameter.

3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psiand kPa.

7. Pointer: Dark-colored metal.
8. Window: Polycarbonate
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent full scale
11. Warranty: Five (5) years

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers and products: as per vendor list.
2. Standard: ASME B40.100.
3. Case: Liquid-filled Sealed, back pressure relief type(s); Stainless Steel or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psiand kPa.
8. Pointer: Dark-colored metal.
9. Window: Polycarbonate
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent full scale
12. Warranty: Five (5) years

2.7 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads, rated formaximum pressure of 10,000 psi and maximum temperature of $343^0$ C.
B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 (DN 8) pipe threads, rated for maximum pressure of 500 psi and maximum temperature of $360^0$ C.
C. Valves: Brass ball, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.
D. Warranty: Warranty for all accessories should be five (5) years

2.8 TEST PLUGS

A. Manufacturers and products: as per vendor list.
B. Description: Test-station fitting made for insertion in piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extendedstem on units to be installed in insulated piping.
D. Thread Size: NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
F. Core Inserts: Buna N (NBR) self-sealing rubber.
G. Warranty: Five (5) years

2.9 TEST-PLUG KITS

A. Manufacturers and products: as per vendor list.
B. Furnish THREE test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be ofdiameter to fit test plugs and of length to project into piping.
C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F(minus 18 to plus 104 deg C).
D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 400 psig (0 to 2760 kPa).
E. Carrying Case: Metal or plastic, with formed instrument padding.
F. Warranty: Five (5) years

2.10 SIGHT FLOW INDICATORS

A. Manufacturers and products: as per vendor list.
B. Description: Piping inline-installation device for visual verification of flow.
C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
D. Minimum Pressure Rating: 150 psig (1034 kPa).
E. Minimum Temperature Rating: 200 deg F (93 deg C).
F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2.11 FLOW METERS

A. Orifice Flow meters:
    1. Manufacturers and products: as per vendor list.
    2. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
    3. Flow Range: Sensor and indicator shall cover operating range of equipment or systemserved.
    4. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation betweenpipe flanges.
        a. Design: Differential-pressure-type measurement for water.
        b. Construction: Cast-iron body, brass valves with integral check valves and caps,and calibrated nameplate.
        c. Minimum Pressure Rating: 300 psig (2070 kPa).
        d. Minimum Temperature Rating: 250 deg F (121 deg C).
    5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch- (152-mm-) diameter, or equivalent, dial with

fittingsand copper tubing for connecting to sensor.
   a. Scale: Gallons per minute (Liters per second).
   b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensorand having two 12-foot (3.7-m) hoses, with carrying case.
   a. Scale: Gallons per minute (Liters per second).
   b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
7. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
8. Conversion Chart: Flow rate data compatible with sensor and indicator.
9. Operating Instructions: Include complete instructions with each flowmeter.

B. Pitot-Tube Flow meters:
1. Manufacturers and products: as per vendor list.
2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or systemserved.
4. Sensor: Insertion type; for inserting probe in piping and measuring flow directly ingallons per minute (liters per second).
   a. Design: Differential-pressure-type measurement for water.
   b. Construction: Stainless-steel probe of length to span inside of pipe, with integraltransmitter and direct-reading scale.
   c. Minimum Pressure Rating: 150 psig (1035 kPa).
   d. Minimum Temperature Rating: 250 deg F (121 deg C).
5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
6. Integral Transformer: For low-voltage power connection.
7. Accuracy: Plus or minus 3 percent.
8. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
9. Operating Instructions: Include complete instructions with each flowmeter.

C. Turbine Flow meters:
1. Manufacturers and products: as per vendor list.
2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or systemserved.
4. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping andmeasuring flow directly in gallons per minute (liters per second).
   a. Design: Device or pipe fitting with inline turbine and integral direct-reading scalefor water.
   b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
   c. Minimum Pressure Rating: 150 psig (1035 kPa).
   d. Minimum Temperature Rating: 180 deg F (82 deg C).
5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
6. Accuracy: Plus or minus 1-1/2 percent.

7. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
8. Operating Instructions: Include complete instructions with each flow meter.

D. Venturi Flowmeters:
1. Manufacturers and products: as per vendor list.
2. Description: Flow meter with calibrated flow-measuring element, hoses or tubing, fittings,valves, indicator, and conversion chart.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or systemserved.
4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.

a. Design: Differential-pressure-type measurement for water.
b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
c. Minimum Pressure Rating: 250 psig (1725 kPa).
d. Minimum Temperature Rating: 250 deg F (121 deg C).
e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
f. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
g. Flow Range: Flow-measuring element and flow meter shall cover operating rangeof equipment or system served.

5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flow meter element, and having 6-inch- (152-mm-) diameter, or equivalent,dial with fittings and copper tubing for connecting to flow meter element.
a. Scale: Gallons per minute (Liters per second).
b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flow meter element and having two 12-foot (3.7-m) hoses, with carrying case.
a. Scale: Gallo ns per minute (Liters per second).
b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
7. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
8. Conversion Chart: Flow rate data compatible with sensor.
9. Operating Instructions: Include complete instructions with each flow meter.

2.12 THERMAL-ENERGY METERS

A. Impeller-Turbine, Thermal-Energy Meters:
1. Manufacturers and products: as per vendor list.
2. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
3. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; forinstalling in piping.

a. Design: Total thermal-energy measurement.
b. Minimum Pressure Rating: 150 psig (1035 kPa).
c. Minimum Temperature Range: 40 to 250 deg F (5 to 121 deg C).

4. Temperature Sensors: Insertion-type transducer.
5. Indicator: Solid-state, integrating-type meter with integral battery pack; for wallmounting.
   a. Data Output: Six-digit electromechanical counter with readout in kilowatts perhour or British thermal units (joules).
   b. Battery Pack: Five-year lithium battery.
6. Accuracy: Plus or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flowin kilowatts per hour or British thermal units (joules).
8. Strainer: Full size of main line piping.
9. Operating Instructions: Include complete instructions with each thermal-energy metersystem.

B. Ultrasonic, Thermal-Energy Meters:
1. Manufacturers and products: as per vendor list.
2. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, andconnecting wiring.
3. Flow Sensor: Transit-time ultrasonic type with transmitter.
4. Temperature Sensors: Insertion-type or strap-on transducer.
5. Indicator: Solid-state, integrating-type meter with integral battery pack.
   a. Data Output: Six-digit electromechanical counter with readout in kilowatts perhour or British thermal units (joules).
   b. Battery Pack: Five-year lithium battery.
6. Accuracy: Plus or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flowin kilowatts per hour or British thermal units (joules).
8. Operating Instructions: Include complete instructions with each thermal-energy metersystem.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in pipingtees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings ifrequired to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connectcases with tubing and support tubing to prevent kinks. Use minimum tubing length.
G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at themost readable position.
I. Install remote-mounted pressure gages on panel.
J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
K. Install valve and syphon fitting in piping for each pressure gage for steam.
L. Install test plugs in piping tees.
M. Install flow indicators in piping systems in accessible positions for easy viewing.
N. Assemble and install connections, tubing, and accessories between flow-measuring elementsand flow meters according to manufacturer's written instructions.
O. Install flow meter elements in accessible positions in piping systems.
P. Install wafer-orifice flow meter elements between pipe flanges.
Q. Install differential-pressure-type flow meter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
R. Install permanent indicators on walls or brackets in accessible and readable positions.
S. Install connection fittings in accessible locations for attachment to portable indicators.
T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
U. Install thermometers in the following locations:
    1. Inlet and outlet of each hydronic zone.
    2. Inlet and outlet of each hydronic boiler.
    3. Two inlets and two outlets of each chiller.
    4. Inlet and outlet of each hydronic coil in air-handling units.
    5. Two inlets and two outlets of each hydronic heat exchanger.
    6. Inlet and outlet of each thermal-storage tank.
    7. Outside-, return-, supply-, and mixed-air ducts.
V. Install pressure gages in the following locations:
    1. Discharge of each pressure-reducing valve.
    2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
    3. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service andmaintenance of meters, gages, machines, and equipment.
B. Connect flow meter-system elements to meters.
C. Connect flow meter transmitters to meters.
D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping and Glycol Piping: Minus10 to plus 70 deg C.
B. Scale Range for Condenser-Water Piping: 0 to plus 150 deg C
C. Scale Range for Air Ducts: 0 to plus 150 deg C.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 600 psi (0 to 4000 kPa).

B. Scale Range for Condenser-Water Piping: 0 to 200 psi (0 to 1400 kPa).

# 4.0 FRESH AIR HANDLING UNIT

## 1.0 GENERAL

## 1.1 WORK INCLUDED:

1.1.1 Compliance with sections of Division 1, General Requirements and documents referred to therein.

1.1.2 Conform to General Requirements for Mechanical Services of Division

## 1.2 DESCRIPTION OF WORK

1.2.1 Furnish and install packaged air handling unit as shown on drawings.

1.2.2 Types of packaged air handling units specified in this section include Indoor draw through type unless otherwise indicated. Provide the following electrical work in accordance with the requirements of Division 16:

a) Power supply wiring from power source to power connection on unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory installed by manufacturer.
b) Interlock wiring between electrically operated equipment units and between equipment and field installed control devices.
c) Control wiring between fields installed controls, indicating devices, and unit control panels.

## 1.3 QUALITY ASSURANCE /MANUFACTURER CERTIFICATION:

1.3.1 Manufacturers of air handling units shall have the following certifications as a proof of quality assurance:

1.3.2 ISO 9001:2000 certification for product quality.

1.3.3 Manufacturers of air handling units strictly to have active Eurovent certification (proof of certification must be submitted from the respective website on the date of submission) as per EN1886 as per below minimum standards:

a) Casing strength to Class D1
b) Casing air leakage minus 400 Pa to Class L1
c) Casing air leakage plus 700 Pa to Class L1
d) Thermal transmittance Class T2
e) Thermal bridge factor Class TB3
f) Filter frame leakage class F9
g) Acoustic Insulation as mentioned below:

| HZ | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|
| dB | 12.5 | 11 | 9.6 | 13.8 | 26.6 | 32.5 | 41.3 |

1.3.4 Insulation shall be CFC free Polyurethane type

1.3.5 Airtight seal material should meets NFPA 90A requirements for flame spread and smoke generation

1.3.6 Casing sheet metal should withstand 500 hours salt spray exceeding ASTM B117

1.3.7 Air filters performance shall be according to ASHRAE Standard 52-76 or EUROVENT Standard 5/6

1.3.8 Heating Elements shall be manufactured in accordance with NEC and UL Space Heating Standard No 1996

1.3.9 Fan performance shall be tested and certified to DIN and AMCA Standard

1.3.10 Fan motor shall be of IE2 energy grade and conform to IEC Standard.

1.3.11 Energy Recovery Wheels shall be AHRI or EUROVENT certified.

1.3.12 Product of manufacturer regularly engaged in production of Air handling units for more than 10 years.

## 1.4 SUBMITTALS

1.4.1 Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings fan performance with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials, and installation instruction.

1.4.2 Shop Drawings : Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.

1.4.3 Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air handling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory – installed and portions to be field- installed.

1.4.4 Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals.

1.4.5 Submit external static pressure calculations based on actual shop drawings for approval by Consultant before final selection of units.

## 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

1.5.1 All units shall be completely shrink-wrapped from the factory for protection during shipment.

1.5.2 All units shall be using transport brackets in fan section, tighten spring bolt and fan discharge cover for protection during shipment.

1.5.3 All units shall be delivered with factory installed shipping skids and lifting holes.

1.5.4 Handle air handling units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air handling unit manufacturer.

1.5.5 Store air handling units in clean dry place and protect from weather and construction traffic.

1.5.6 Comply with manufacturer's rigging and installation instructions for unloading air handling units and moving them to final location.

1.5.7 Provide factory assembled air handling unit in configuration as indicated and scheduled on drawings. Unit shall include all specified components installed at the factory. The complete unit shall be manufactured to meet the requirements of the schedules and drawings so as to make a complete unit to meet the performance requirements.

# 2.0 PRODUCTS

## 2.1 CASING CONSTRUCTION:

2.1.1 The unit construction shall consist of a frame and panels.

2.1.2 Profiled casing sides of aluminum anodized E6 material finish.as per DIN 17611

2.1.3 The frame holds a 60-mm double-skin casing wall with panels, doors, inspection hatches and removable center posts.

2.1.4 Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit, thereby facilitating maintenance work.

2.1.5 Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside. The construction should reduce machine noise, absorbing vibration and avoiding air leakage.

## 2.2 PROFILE FRAME AND PANEL CONSTRUCTION:

2.2.1 Heavy-duty profile frame made from Aluminum, fully welded and hermetically sealed at the ends. Profile shall be more robust and can be repeatedly disassembled. Profile shall be coated in according with ASTM A 653/A 653 M-01

2.2.2 Panels are manufactured from steel sheets treated with weather and scratch-resistant coating RAL 7035 as per the AHU selection. Roof are painted with highly durable heat hardened polyester based powder paint RAL 7035 with 50 microns film thickness.

2.2.3 The paint shall conform to ASTM D-2201 and ASTM D-2092 for gloss, adhesion, impact resistance, withstand up to ASTM B117 500 hours salt spray resistance test.

2.2.4 Modular panel is design to be rigid and sturdy made up of durable galvanized sheet steel treated with weather and scratch-resistant coating on both sides, base color grey (RAL-7035).

2.2.5 The standard casing wall construction shall consists of 0.8 mm internal and external skin with injected polyurethane, fire retardant according to DIN 4102 class B2, 40kg/m3 density, 0-19 W/M ºC K value

2.2.6 The doors and the panels shall be formed by bending the panel external sheet metal over the internal sheet metal so that closed panel structure resistant to water and steam will be obtained. Bended external sheet metal structure of the panel (preventing the formation of sharp edges) also reduces the risk of any possible injuries during mounting and maintenance.

2.2.7 Panel shall be tested for strength at ± 1000 Pascal with deflection < 1 mm/m and without permanent deflection at ± 2500 Pascal, confirmed to EN 1886 Class D1.

2.2.8 Panels shall be manufactured from steel sheets treated with weather and scratch-resistant coating on both sides RAL 7035, frames and roof are painted with highly durable heat hardened polyester based powder paint RAL 7035 with 50 microns film thickness

2.2.9 The paint shall conform to ASTM D-2201 and ASTM D-2092 for gloss, adhesion, impact resistance, withstand up to 1000 hours salt spray resistance test, exceeding 500 hours ASTM B117

2.2.10 Thermal Transmittance, U-value tested at 1-W/m2K confirmed to Eurovent EN 1886 Class T2.

2.2.11 Thermal Bridging Factor kb 0.62 conformed to Eurovent EN 1886 Class TB2

2.2.12 Fasteners shall be zinc coated comply with 400 hours salt spray resistance test ASTM B117

2.2.13 Panels and profile frames shall be assembled with a closed cell self-adhesive polyethylene seal installed in between them to prevent air leakage, reduce vibration noise and minimized thermal losses.

2.2.14 Closed cell self-adhesive poly-ethylene seal shall avoid external water from penetrates inside the unit and shall block heat infiltration and avoid external contamination into the conditioned space area inside the unit.

2.2.15 The construction of panels to the profile frames shall provide minimum air leakage Class L1. Casing leakage tested and conformed to Eurovent Standard EN 1886.

2.2.16 A base shall be provided under the unit to avoid contact of the bottom surface of the unit with the others surfaces during transportation and installation, and to ensure required body strength. The height of the base shall be 62 mm.

2.2.17 Roof curb profiles, where the unit will be carried shall be of closed welded section and thus minimize the risk of its deformation during transportation.

2.2.18 Roof curb shall be from heavy gauge (2mm) galvanized steel, longitudinally welded with the profile, connected with 3 mm crossbar to form strong and rigid structure and shall be supplied with multiples holes to suit optimum hoisting stability.

2.2.19 In case of unit installation at roof with direct sun exposure, unit shall be provided with whether proof canopy which prevents water penetration on top surfaces of the AHU when installed outdoor. Silicone shall be applied to the profile joints on the outer surface of the unit to increase the insulation against water. Construction shall be of heavy gauge (G16) galvanized steel grade G90 and powder painted RAL7035 with 50 microns thick.

## 2.3 DOORS AND ACCESS PANELS:

2.3.1 Panels shall be hinge type with handle and lock that can only be opened with a special key. Access door panel shall be equipped with metal hinges with plastic cover. It shall be with EPDM rubber sealed at door perimeter which provides an effective airtight and protection from heat gain.

2.3.2 Access door type shall be at the Fan Section, filter section and the Mixing Box Section. View port shall have double skin (there shall be glass on both interior and exterior surfaces of the viewing glass).

2.3.3 Unit shall have hinged type safety access panels accessible internally and externally.

2.3.4 Removable access panels shall be fixed to the profile frames with bolts which provide additional access to ease mobility for major service work on large and heavy component such as coil, fan and motor.

## 2.4 FAN SECTION AND DRIVE ARRANGEMENT:

2.4.1 Fans shall be double inlet double width, forward or backward curved centrifugal type fans.

2.4.2 Fans shall have sound power level measurement according to AMCA 300 & 301. Sound power level measured values shall be converted to other operating speeds with a calculation procedure described in the BS 848 Part 2 standard. Outlet side sound power levels shall be according to ISO 5136, DIN 45635 Part 9, BS 848 Part 2 Chapter 6 or AMCA 330-97.

2.4.3 Fan shall not exceed a maximum outlet velocity of 14 m/sec.

2.4.4 Fan wheel shall be statically and dynamically balance within fan operating speed in compliance to DIN ISO Standard 1940 with grade G4. Shaft diameters are selected to achieve a safety factor for critical speed ≥ 1.25 higher than the maximum operating speed.

2.4.5 Blades of the fans shall be from galvanized steel further treated with polyester powder coat RAL 7030.

2.4.6 Fan scroll from hot dip galvanized steel JIS G3302 Grade SGCC with no electrical spot welding as the scroll back is joined to the side plates with the Pittsbourgh lock forming system which prevents any oxidation starting from the welding spots.

2.4.7 Bearings shall be for heavy-duty service with nominal life expectancy of 40,000 L10 operating hours (according to DIN ISO 281 Section 1). Bearing shall be life lubricated type

2.4.8 Motor design and performance shall be IE1 class according to IEC Standards. Fan motor shall be able to operate at maximum 50% of rated speed. At 50% of rated speed, the fan motor shall deliver 80% of rated torque and 40% of rated power.

2.4.9 Standard fan's motor shall be a Totally Enclosed Fan Cooled type (TEFC).

2.4.10 Motor's frame shall be of cast iron. Motor protection shall be with IP 55, motor shall be protected against dust and protected against jets of water from all direction.

2.4.11 Insulation shall be Class F (T max 155 ºC) and Temperature Rise Class B (ΔT 80K). Motor shall able to operate at 50°C operating temperature.

2.4.12 Motor shall have a thermal reserve to spare for overheating when induced by voltage fluctuation at ±10%, compliance to IEC 34-1.

2.4.13 Thermal Overload Protection "Normally Closed Thermostat" (PTO) shall be a standard accessory. PTO shall provide general surveillance for non-transient overload. Bi-metallic strip with normally closed contact is indirectly heated when line current passes through the strip and shall shut down or restores supply circuits as necessary. PTO connection shall be mounted to control circuit and suitable for manual or automatic reset.

2.4.14 Positive Temperature Coefficient thermistor (PTC) shall provide general surveillance for transient overload.

2.4.15 Fan and motor assemble on a common base, FMB, fabricated from heavy gauge galvanized steel.

2.4.16 Motor rail shall be a slide rail type for flexible belt tensioning. Fan and motor assembly are totally isolated from AHU casing structure by isolators and flexible canvas. Rubber isolators shall be capable to achieve standard vibration isolation efficiency up to E85.

2.4.17 Spring isolator with 250 micron powder painted and with 50 mm free deflection shall be capable to achieve critical vibration isolation efficiency E95 up to E99.9. Fan shall be isolated to discharge panel with fire retardant fan flexible connection.

2.4.18 Fan drive package shall consist of fan and motor pulleys and assembled with Wedge belts. Variable pitch pulley shall be available at motor drive up to 7.5 KW

2.4.19 Standard belt Service Factor designed at minimum SF1.1 and flexible to reach up to SF1.5.

2.4.20 The static resistance of the various systems have been calculated by the Engineer and the Sub-Contractor shall be required to check and recalculate the resistance in the system taking into consideration the resistance through the equipment that is finally approved and satisfy himself that the resistance figures for the fan is adequate. If necessary the total fan resistance shall be adjusted and agreed with the Engineer. No claim shall be allowed by the Engineer if the Sub-Contractor falls to fully acquaint himself with the capabilities of the various systems. The fan shall have provision for connecting variable frequency device.

2.4.21 All motors shall be rated for use with variable frequency drive (VFD) shall be Inverter duty" or "drive duty" motors, compatible with the drive to which it is connected. Use of motor with a VFD shall not adversely affect the operation, useful life, or warranty of the motor.

## 2.5 COIL SECTION

2.5.1 Coils shall be fully enclosed within the coil section.
2.5.2 Removable panel shall be assembled at both left and right side of coil section.
2.5.3 Coil panels shall be bolted externally; air tight sealed, easy removal and quick reassemble to facilitate access for service and maintenance.
2.5.4 Coils shall be of the cartridge type, mounted on a condensate drain pan with a slide in-out coil track so that the complete assembly is wholly removable for easy maintenance.
2.5.5 Coils shall be fabricated and tested in accordance with ASHRAE/ANSI 15 Safety Code for Mechanical Refrigeration (latest edition).
2.5.6 Coil assembly shall sit within coil section face area and seal to the casing wall to avoid air by-pass, and shall be plate by-pass of removable type for easy access to header section
2.5.7 Coils shall be housed in factory fabricated frame independent of unit casing and shall be individually removable. Multiple coils shall be mounted on independent support structure. Directly stacking coils using coil casing as structural support for other creep is not acceptable.
2.5.8 Drain pan shall be made of galvanized steel and powder painted.
2.5.9 Drain pan shall be mounted in slanted angle at one side for complete and positive drainage; drain connection shall be at one side.
2.5.10 Drain pan shall be insulated with 60 mm panels from all sides.
2.5.11 Eliminator shall be provided for coil face velocity more than 2.5m/sec.
2.5.12 Mineral reinforced PVC eliminator shall be provided which are highly efficient and can trap moisture molecules at much higher velocity.
2.5.13 Fins shall be a collar type, assembled with 12.7 mm OD copper tubes and mechanically bonded to copper tube for greater heat transfer coefficient.
2.5.14 Coil construction materials shall be of Seamless copper tube of 12.7 OD with 0.4mm wall thickness and aluminium fin 0.12mm thick.
2.5.15 Coil frames shall be made from galvanized steel and painted for additional protection.
2.5.16 Headers shall be heavy section black steel barrel and connection shall be with threaded end steel stub.
2.5.17 Header's connections shall be sealed internally and externally with rubber seal to avoid air leaking through gap at coil panels.
2.5.18 Coils shall be "counter" flow and equipped with vent and drain.
2.5.19 The coil shall be tested at 300-psig submerged under water, designed to operate up to 230 psig (16 Bar) at 200°F (93°C).
2.5.20 The manufacturer shall guarantee that each coil can meet the specified duty.
2.5.21 Coils shall be pitched and installed as required in the manufacturer's installation instructions.

## 2.6 AIR FILTERS

2.6.1 The pre-filter section shall contain Synthetics media G3 50mm thick, with 80-90% arrestance efficiency.
2.6.2 Pre-filter frame shall be made from galvanized steel.
2.6.3 Pre-filter shall be in flat form and should be cleanable and washable.

2.6.4 The bag filters F7 shall be high capacity filters with minimum dust spot efficiency of 80-85%. They shall comprise of a corrosion resistant frame housing the filter media. The media cartridge shall be pre-formed and shall consist of synthetic media and shall be supported with galvanized steel frame. Filter shall be capable to operate under high humidity conditions.

2.6.5 Soft bag filter length shall not be less than 500mm.

## 2.7 FILTER MOUNTING FRAME:

2.7.1 Mounting frame shall be made from aluminum and filter can be accessed on to the mounting frame from “front” (front or rear access or existing frame mounting) or “slide” (side mounting) type.

2.7.2 Frame mounting frame or Slide rails should be sealed for a minimal air leak Class F9 according to EN 1886.

## 2.8 MIXING BOX (if applicable – refer schedule)

2.8.1 Dampers construction are made from heavy gauge galvanized steel for sturdy and rigid structure.

2.8.2 Nylon or bronze bushing, metal side linkages enable damper blades to operate within low torque.

## 2.9 ELECTRIC HEATERS (if applicable – refer schedule)

2.9.1 Electric heater shall be of the cartridge type.

2.9.2 Heaters shall be framed with a slide in-out track so that the complete assembly is removable.

2.9.3 Electric heater shall be of Closed Tubular Finned Type, composition 80% Ni and 20% Cr.

2.9.4 Heating component shall be according to AISI 321 and AISI 430.

2.9.5 Assembly of the heating element shall be secured inside the stainless steel spherical sheathed fins copper tube (except for heater for 460 volt heater – without spherical fins).

2.9.6 Basic components of heater assembly shall be airflow switch, power terminal board, grounding lug and primary & secondary over load temperature sensor.

2.9.7 Components shall be assembled inside terminal box integrated with heating elements frame assembly.

2.9.8 Frames shall be from a heavy gauge (G16) galvanized steel frame.

## 2.10 DAMPERS (if applicable – refer schedule):

2.10.1 Damper blades shall be with a single skin laminar type, made from galvanized steel, operate in parallel or oppose blades position.

2.10.2 Class IV air leakage, 0.5% leakage rate at 100 Pascal ΔP per square meter damper area, according to UL555S.

2.10.3 Shafts are with 12 mm diameter; seated on non-corrosive bronzed or nylon bushing for less resistance, free maintenance and lowest torque.

2.10.4 Extended shaft length is provided for provision to electrical motor actuator to regulate dampers blades opening and closing.

2.10.5 Frames are made from galvanized steel, reinforced at very 1200-mm and flanged at both ends to facilitate external ductwork or sand trap louvers connection.

2.10.6 Metal linkage made from steel pushrods is installed for dampers with top-rear position to allow damper to inter connected at open and closed position.

2.10.7 Damper blades quadrant shall be assembled to guide blades opening and closing position.

2.10.8 Hinged type access door is assembling at Mixing Box

End of Section

## 5.0 FAN COIL UNIT

**1.0** GENERAL

**1.1 WORK INCLUDED**

1.1.1 Compliance with sections of Division 1, General Requirements and documents referred to therein.

1.1.2 Conform to General Requirements for Mechanical Services of Division (…..)

**1.2** DESCRIPTION OF WORK

12.1 Furnish and install fan coil units as indicated on drawings

1.2.2 Types of fan coil units specified in this section include the following:
Horizontal/Vertical units for concealed installations. Horizontal Cabinet units for exposed installations.

**1.2.3** Refer to other Division **… sections for vibration control units used in conjunction with fan coil units.**

1.2.4 Refer to other Division … sections for chilled water and condensate drain piping required in conjunction with fan coil units.

1.2.5 Refer to Division ….sections for the following work:
Power supply wiring from power source to power connection on unit. Including starters, disconnects, and required electrical devices, except where specified as furnished, or factory installed by manufacturer.

Interlock wiring between electrically operated equipment units and between equipment and field installed control devices.

1.2.6 Provide the related electrical works of this section to comply with the requirements of

Division 16 sections.

1.3 QUALITY ASSURANCE

1.3.1 Manufacturer's Qualifications: Firms regularly engaged in manufacture of fan coil units with characteristics, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Manufacturers shall have ISO 9001 certification.

1.3.2 Codes and Standard:

ARI Compliance: Test and rate fan coil units in accordance with ARI 441 or EUROVENT "Standard for fan coil units"; display certification symbol on units of certified models.

ASHRAE Compliance: Construct and install cooling coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration" and ASHRAE 33-for testing air coils.

a) Insulation and adhesive shall meet NFPA-90A requirements for flame spread and smoke generation. All equipment wiring shall comply with NEC requirements.

b) Unit capacity ratings shall be certified in compliance with industry Standard 441-66 for equipment, testing, and rating of fan coil air conditioners as administered at A.R.I. or equivalent EUROVENT in European Standard. When units do not have A.R.I or EUROVENT certified ratings, the contractor must perform capacity tests of the completed installation, which are witnessed by the Consultant to confirm specified capacity is achieved while not exceeding specified sound power levels.

**1.4 SUBMITTALS**

1.4.1 Product Data : Submit manufacturer's technical product data for fan coil units showing dimensions, weights, capacities, ratings fan performance with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials, and installation instruction.

1.4.2 Shop Drawings : Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.

1.4.3 Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to fan coil units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory - installed and portions to be field- installed.

1.4.4 Maintenance Data:Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals.

**1.5 PRODUCT DELIVERY, STORAGE AND HANDLING**

1.5.1 Deliver fan coil units with factory installed shipping skids and lifting lugs, pack components in factory fabricated protective containers.

1.5.2 Handle fan coil units carefully to avoid damage to components, enclosures, and finish.

1.5.3 Do not install damaged components; replace and return damaged Components to air handling unit manufacturer.

1.5.4 Store fan coil units in clean dry place and protect from weather and construction traffic.

1.5.5 Comply with manufacturer's rigging and installation instructions for unloading fan coil units, and moving them to final location.

**2.0** PRODUCTS

**2.1 MATERIALS**

Units shall be complete with chilled water coil(s), electric heating coil (where indicated on schedules) fan(s), motor(s), drain pan, and all required wiring, piping, controls and special features.

**2.1.1 Unit Chassis**

Horizontal/Vertical Base Unit with Plenum for concealed installation shall have a factory installed, galvanized steel plenum section and permanent washable filter. The plenum shall be either bottom or rear return, lined with 10mm thick PU insulation or equivalent based on manufacturer standard and include a removable panel to provide an access to the fan/motor assembly.

Horizontal cabinet unit for exposed installation shall be constructed of steel with re-coat able baked enamel finish. Color to be approved by the Consultant. Cabinet shall be lined with thick PU insulation or equivalent based on manufacturer's standard and have removable bottom access panel. Unit shall include hinged bar type return air grille on rear of unit with permanent washable filter and integral double deflection supply grille.

**2.1.2 Fan /Motor**

Fans shall be direct driven, double width fan wheels shall have forward curved blades, and be statically and dynamically balanced.

Fan motors shall be 3 speed permanent split capacitor type with sleeve type bearings and oversized oil reservoirs. Motor shall be suitable for 240V single phase, 50Hz provided with internal thermal protection.

**2.1.3 Coil**

Coil shall be equipped with a 3 row coil (minimum) for installation in a 2 pipe system. Coils shall have 7 mm copper tubes, 0.110 mm thick aluminum fins bonded to the tubes by mechanical expansion and have a working pressure of 16 bar. Each coil shall have a manual air vent and sweat connections for copper tubes. All coils shall be leak tested and proven tight. Alternate copper tube diameters shall be acceptable depending upon manufacturing standards of the manufacturer and subject to approval by Consultant.

The coil shall be pressure tested to 2.8 MPa (for a working pressure of 1.6MPa) and dehydrated before assembly.

**2.1.4 Drain pans**

The drain pan shall be constructed of galvanized steel extending the entire length and width of the coil(s) and pitched for drainage. Drain pan inside powder coated and outside insulated. An extension drain pan shall be provided for installation at the jobsite under the valve package.

**2.1.5 Electric Heaters**

Where indicated on schedules unit shall be equipped with electric resistance strip heaters mounted on the entering air side of the cooling coil.

Heaters shall include automatic reset high limit cut out, contactor, factory furnished junction box and fuse to protect the motor.

Heaters shall be single stage single phase, for 50Hz applications. Capacity shall be as shown on the equipment schedule.

Control circuit for single power source connection shall be provided for motors and heaters.

## 3.0 EXECUTION

### 3.1 INSTALLATION

3.1.1 Electric wiring between fan motor, fan switch, and automatic control valve, shall be carried out to comply with the requirements as per Electrical specifications of Division 16 (Electrical). The Contractor shall provide the necessary quick disconnects for easy removal of the fan section and also provide suitable terminals for field connections of power and control thermostat wiring.

3.1.2 Air filter shall be permanent washable filters for each fan coil unit. The filters shall be constructed from non-ferrous metal with 21mm thickness and a minimum of 70% gravimetric efficiency.

3.1.3 The Contractor shall ensure that units are installed level to ensure that condensate from the drain pan flows freely. Provide drain lines of uPVC Class E to BS 3505, 25 mm diameter minimum laid to falls of 1:100, and insulated in accordance with Specification requirements.

Extend condensate to drain to the nearest waste line.

3.1.4 Provide ductwork distribution and terminal air distribution device to adequately condition the spaces served by the individual fan coil units. Final distribution shall suit the actual room details and shall in each case be subject to the approval of the Consultant.

**3.2 STARTUP AND INSTRUCTIONS**

Check vibration and correct as necessary for air balance work.

After air balancing is complete and permanent sheaves are in place, perform necessary field mechanical balancing to meet vibration tolerance in Section 15070, Mechanical Sound, vibration and Seismic Control.

**3.3 TESTING, BALANCING AND COMMISSIONING**

Testing, Balancing and Commissioning shall be as referred to throughout this Section, and in Accordance with Section …. Testing, Adjusting and Balancing from third party.

The test rig and all necessary blanks for the purpose of sealing the ductwork under test shall be provided, blanks shall be removed after the test has been approved for each section of the ductwork.

End of Section

## 6.0 CLOSED LOOP PRESSURIZATION AND MAKE UP WATER SYSTEM

1) Unit shall be selected for either heating or cooling as required by the drawings and documents.
2) The pressurization unit shall be complete package unit containing expansion vessel(s), buffer vessel, pumps, break tank and all controls, interlocks and ancillary equipment necessary to maintain the system static pressure in accordance with the operating conditions.
3) Pressure maintenance station should be pump based and should have a control unit with microprocessor control, color touch screen display, Ethernet connection to the web. Mod Bus connection to BMS systems, vacuum cyclonic degasser, water make-up, buffer vessel, primary vessel for expansion water volume and if required secondary vessel(s).

4) The actual system water contents and the capacity of the expansion vessels, buffer vessel and break tank shall be calculated by the manufacturer to achieve and accept the total system contraction/expansion volume of water.
5) Control unit must have 2 pumps with time/load dependent switching, 2 spill valves, safety valve, degassing vessel, solenoid valve, break tank, feedback relays and microprocessor.
6) Control unit should guarantee highest precision where the pressure can vary only with ± 0.2 bar around the set point.
7) Pump shall maintain smooth operation with pressure gradient-controlled speed and highest system performance development, system protecting and minimized switching frequency operation with pressure gradient-controlled pump speed that ensures highest performance development with self-optimized partial load operation, dynamic start/stop and controlled number of pumps starts per hour.
8) Control unit shall have a water make-up with contact meter and a break tank type AB according to EN1717, SVGW-tested.
9) Control unit shall maintain degassing process in a special vessel with high vacuum on approx., atmospheric gas saturation, thus completely bubble-free water operation for getting rid of dissolved gases in the system.
10) Control unit should be CE-tested, according to the requirements of the European Directives PED/DEP 97/23/EC, 2004/108/EC, 2006/95/EC.
11) Microprocessor control shall ensure an intelligent, secure system operation, self-optimizing with memory function.
12) Microprocessor control shall have illuminated graphical color touch screen display for the representation of all relevant parameters, with numeric and graphical display of the pressure and water level in the vessel.
13) Control unit shall withstand a maximum admissible system pressure.
14) Protective class of the control unit should be IP54.
15) Buffer vessel shall be provided to compensate for minor pressure changes and prevent frequent switching of the pump and the spill valve.
16) Vessels should be made-up from steel, welded and factory painted.
17) Vessels should be CE-tested, according to the requirements of the European Directives PED/DEP 97/23/EC.
18) A measuring foot to be used for content measurement, foot ring for upright assembly, including assembly kit for the water-side connection with 2 bar safety valve and ball valve for fast draining.
19) The vessel bag should be made up from airproof Isobutene-Isoprene Rubber (HR) according to EN13831 with reliable protection of the expansion water against the admission of oxygen.
20) The bag should be symmetrically suspended with volcanized O-ring sealing, little circumference, no wear.

21) The bag should be tested according to Pressure Equipment Directive with 5-years warrantee.
22) The bag should have the possibility to be vented at the top and drained at the bottom.
23) The bag must have surpassed the requirements of DIN 4807-T3 in order to insure long life cycle and extremely reliable operation.
24) Vessel should be suitable for temperatures between -10 deg C and 120 deg C with antifreeze capability up to 50 %.
25) Bag temperature rating shall be higher than the water temperature by a minimum of 20 deg C. The minimum bag rating temperature shall be 70 deg C.
26) Production and quality management shall be certified and monitored according to ISO 9001:2000.
27) The control panel shall display and communicate the following points back to the BMS system:
28) System static pressure at the point of degasser connection
29) Water content in the expansion vessels
30) Operation mode (auto/standby)
31) Collective alarm
32) Motor protection of the pump triggered
33) Pump status

34) Solenoid valve status
35) Water make-up status
36) AB. Standard of Acceptance - IMI Pneumatex Transfero TV Connect, or approved equal.

End of Section

## 7.0 AIR SEPARATORS

Combination Air Separator / Strainer:

- Steel, tested and stamped in accordance with ASME (BPV VIII, 1); for 25 bar rated pressure, with inte-gral 316L SS strainer, tangential inlet and outlet connections, and internal stainless-steel air col-lector tube.
- Strainer perforations to be 3.2 mm (1/8 inch).
- Standard of acceptance: Wessels SPA or approved equal.

End of Section

## 8.0 Chemical Dosing System

The drawing indicates automatic dosing unit for Chilled water dosing system. This can be retained as it is. The Corrosion Inhibitor dosing should be based on conductivity and the micro-biocide dosing via manual dosing for monthly or once in two months dosing.
The location of conductivity sensor across the suction and discharge header is okay. The injection point of chemicals (corrosion inhibitor) can be in the discharge line of the Chilled Water pump sets, as the chemical dosed in the system will get some time for mixing before it reaches the conductivity sensor.
In addition to automatic dosing system, we would recommend you to have a manual dosing pot with sufficient capacity to be installed in between the suction and discharge header to dose the chemicals during any contingency situation.

**General:**

The contractor will furnish and install a chemical feed system for the addition of chemical treatment to the closed water system(s). All equipment, water treatment chemicals, testing equipment and service will be provided by a single water treatment company in order to ensure system compatibility. The water treatment company will be a recognized water treatment specialist, active in this field for ten years and complying with ISO 9001-2000.

**Chemicals:**

For Pre commission cleaning, the system shall be dosed with the prescribed amount of the n o n - acid cleaning agent. Cleaner shall be run into the system and retained for a period of 24 hrs. Or more. At the end of this period the system shall be drained and flushed with clean water. The flushing shall continue till the effluent is clear, colorless, odorless, and free from suspended solids and such that the dissolved iron level is not more than 0.5 ppm
The contractor will furnish chemicals for initial treatment and for maintenance period of 1 year; Nitrite based or approved equivalent chemical to inhibit corrosion and sludge accumulation and a Micro-biocide for microbiological control system. The chilled water parameters shall be maintained as per Table-1
Note**:** The Mechanical Contractor shall advise on the holding capacity of the systems to the Chemical Company, in order to calculate chemical requirement. Space to keep chemicals required for period of one year shall allocate.

**Pot Feeder**:

The feeder will be of welded steel construction and rated for the application. The feeder will have the following features. Tundish, valves, air vent, and wall mounting bracket.

**Automatic Dosing System:**

Conductivity based Automatic dosing system from 'Prominent' or approved equivalent shall be provided so as to proportionally measure the level of corrosion inhibitor in the system and adjust the inhibitor to preset range on an automatic basis.
The automatic controller is complete with dosing pump, chemical tank, low level cut-off switch for

the pump, suction and discharge fittings, tubing, conductivity measuring cell and cell connector etc.

Chilled water parameters are as follows,

**Control Parameters' Window for Chilled Water System.**

| Parameters | Values |
|---|---|
| pH | 8.5 – 10.50 |
| Conductivity, µ siemens/cm | Max 2250 |
| TDS, ppm | Max 1500 |
| Nitrite ppm | Min 700 |
| Dissolved Iron, ppm as Fe | Max 0.5 |

**Microbiological Estimations**:

| Parameters | Values |
|---|---|
| Total viable count, col/ml | Max $10^4$ |

## 2- CONTROL PHILOSOPHY/SEQUENCE OF OPERATIONS

**AUTOMATIC CONTROLLER**

**AUTOMATIC CHEMICAL DOSING FOR CHILLED WATER SYSTEM**

For complete water treatment programme to be fully effective, correct chemical dosing is required. If treatment levels are too low then scale and corrosion and fouling may result. Unfortunately manual dosing is quite unreliable but better results are achieved by automatic dosing which maintains a high level of accuracy.

Automatic dosing system is complete with fully automatic controller, dosing pump, chemical tank, suction and discharge fittings, tubing, conductivity measuring cell and cell connector etc.

The conductivity controller in the system is continuously monitoring the conductivity of circulating water. The Chilled water when dosed with Corrosion Inhibitor gives a particular conductivity value. The conductivity value of the water at the desired Corrosion Inhibitor level is kept as the set point in the controller. Water loss in the system leads to fresh water supply to the system and results is drop in conductivity. When the conductivity drops below the set point, the controller gives signal to the dosing pump to inject the corrosion inhibitor and this will continue till the conductivity reach the desired set point.

The dosing pump is connected with a level switch in the chemical tank to stop the pump when the chemical level goes down as well as to give a signal to the BMS. Run status of the dosing pump is given to BMS as volt free contacts.

## 3- SYSTEM DISCRIPTION

1 No. Manual Dosing pot.
1 No. Conductivity controller with sensor
1 No. Dosing pump
1 No. Low level cut of switch

All the above equipment's have to be installed in its respective locations as shown in the schematic drawing (Refer **the below schematic diagram**). The controller will be installed on a plant room wall and the chemical tanks and dosing pumps will be placed near to the controller. The dosing pumps are directly installed on the chemical tanks and suction and discharge tubing will be connected. Conductivity sensor has to be installed in the sampling point taken across the suction and discharge headers.

**Manual dosing pot –**

Technical/ Operational Details

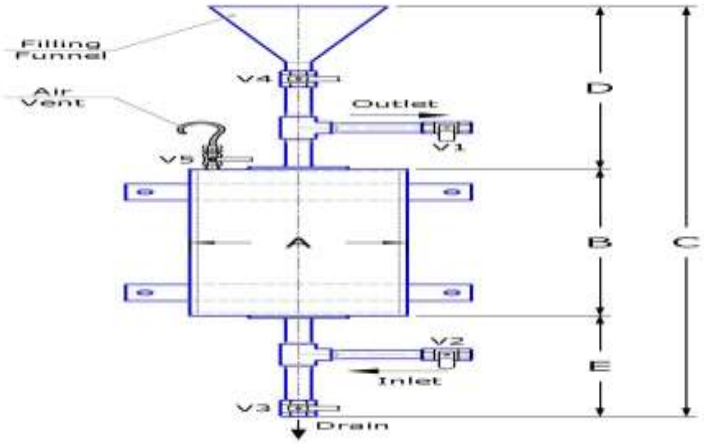
Manual dosing pots are installed in the closed loop chilled water circuits to dose micro biocides on a regular basis. It is also used to dose corrosion inhibitor into the closed loop circuits where an automatic dosing system is not available or to top-up the inhibitor level quickly in emergency situation.

**Specification:**

All feeders are of mild steel welded construction suitable for the working pressures stated. Feeders are supplied complete with control valves, filling valve and funnel to facilitate easy charging of chemicals into the circuit. An optional non-return valve can be fitted between the funnel and filling valve if required to prevent possible blow-back during filling.

**Installation:**

The Feeder should be installed in an accessible area across the suction and discharge lines of chilled water pumps. The unit must be securely fixed to a wall or be floor mounted, it must not be supported from connecting pipe work. In all cases, drain line must be connected to a nearest drain pit.




**4- PROPOSAL / EQP SCHEDULE**

**SCHEDULE OF EQUIPMENT- CHILLED WATER CHEMICAL TREATMENT:-**

INITIAL CLEANING CHEMICAL QUANTITY/INITIAL FILL UP:

| | | |
|---|---|---|
| 1 | Neutral pH Cleaner | 1 Kg/M3 |
| 2 | Passivation Chemical | 100ml/M3 |
| 3 | Nitrite Based Corrosion Inhibitor | 3 Kg/M3 |
| 4 | Micro-biocide - | 100ml/M3 |

EQUIPEMENT SCHEDULE

1. Manual dosing Pot 1 no.

2. Automatic Dosing Systems - (1 Set) consists of

| | |
|---|---|
| Conductivity Controller with Panel & Conductivity Sensor & Adaptor | 1 no. |
| Dosing Pump | 1 no. |
| Dosing tank | 1 no. |
| Low level cutoff switches | 1 no. |

End of Section

## 9.0 Chilled Water Pumps

The Contractor shall supply, install, test and commission the pumps detailed on the drawings and/or referred to in the schedules section of the specification. Chilled water pumps shall be end suction, base mounted pumps, vertically split case centrifugal type capable of delivering liters/second at a total head as scheduled.

The Contractor shall include casting 150mm clear height concrete pump bases or floating floor and for coordinating with the structural engineer to ensure that the bases and any associated equipment weight is accommodated into the structural design.

Chilled water pumps to be installed on inertia bases, as Weicco WIB series or equal and approved. Seals shall be of the mechanical type. The pump shall be constructed from the following materials:

| | |
|---|---|
| Pump casing | Cast iron |
| Impeller | Cast-bronze |
| Shaft | Stainless steel (chrome-iron or nickel-iron) |
| Base plate | Steel |

Casing material shall be cast-iron, precision-manufactured for the best performance and long term duty. Casing shall be designed to operate at working pressure of not less than 150 psig or not less than 1.5 times the specified head on the equipment schedule. The casing shall be tested by hydro static test at 1.5 times of casing design maximum working pressure. Suction and discharge flanged connection shall have the same working pressure as pump casing. Casing shall be provided with tapped and plugged fittings for vent and drain.

Impellers shall be one-piece, cast-bronze both statically and dynamically balanced. Impellers of pumps having 40 mm (1½ inches) and larger discharge connection shall be fully enclosed and hydraulically balanced. Impellers shall be accurately keyed to the shaft and fixed in an axial position by shaft sleeves and separate snap rings. Impellers shall be fully protected against damage due to reverse rotation.

Shafts shall be of stainless steel (chrome-iron or nickel-iron). All shaft threadings shall be external to the water passage and stuffing boxes. Shaft sleeves shall be keyed to the shaft and extended through the stuffing b gaskets shall be provided at sleeve ends to protect the shaft from water corrosion. They are so designed that no dismantling of the pump casing is required to replace the sleeves.

Bearings shall be heavy-duty ball bearings with a minimum average life of 100,000 hours. The bearings shall be greasable, and housed in malleable-iron housing aligned to a bearing bracket by means of large precision registers. Bearings shall be removable without dismantling any rotating element inside the pump. Fit bearings with lubricant retaining and dust excluding seals and grease relief.

Mechanical seals shall be provided. Balance type mechanical seals shall be used when the casing working pressure exceeds 300 psig.

Motor shall be of totally enclosed fan cooled squirrel cage induction motor. Unless otherwise specified, the speed of motor shall not be more than 1500 RPM. Motor shall be suitable for 400V/3Ø/50 Hz power system. The winding insulation shall be of class F. Service factor of motor shall not be less than 1.15. Bearing of motor shall be sealed ball bearing or roller bearing. The

seal of motor shall be of dust and moisture protection type. Motor terminal box shall be water proof. Conduit for terminal box shall be water proof flexible conduit. Motors shall be selected with the minimum efficiencies and power factors. This may require optional high efficiency motors to be provided by suppliers.

Each pump shall be factory assembled and tested per Hydraulic Institute standards. It shall then be thoroughly cleaned and painted with high grade epoxy paint to withstand extreme weather conditions. Pumps shall be installed by following the manufacturer recommendation.

Two differential pressure sensors shall be installed at the most remote part of the networks, to provide speed control to the secondary variable speed chilled water pumps.

The Contractor shall provide bypass valve at two end riser at either end of the school (low flow bypass). The bypass valve shall be differential pressure valve that will open when the pressure rises in the system due to control valves in system closing. A balancing valve shall be provided adjacent to the bypass valve so at commissioning stage the flow can be set to the minimum flow required by the chilled water pump.

The contractor is to submit detailed calculations on the pump flow rate checks and pressure drop checks for approval by the engineer before the pumps are ordered.

END OF SECTION

## 10.0 BTU METERS

A. The energy meter shall comply with the following standards:

EN1434 -1, EN1434-2, EN1434-3, EN1434-4 EN1434-5, EN1434-6, OIML R75, and EN60870-5.

B. The ultrasonic energy meter shall consist of the ultrasonic flow sensor along with the calculator, temperature sensors with integral hardware and software for measuring flow rate, temperature and energy consumption.

C. The Ultrasonic BTU meter shall be factory calibrated as a single unit as per EN1434 Class2 standard. The calibrated certificated shall be furnished along with the delivery of meters.

D. The Energy Meter shall be equipped with an internal M-Bus communication card to operate on a wired M-Bus network including branded CPU and PC. The residential meters with Qp up to 2,5m3/hr shall be powered over M-Bus using battery as a backup. The supplier should confirm the meter to operate minimum 16 years without change of battery at site. The meter that uses external main power supply will not be acceptable.

E. The energy meter shall be used for cooling applications

F. The meter should be operational for a minimum 16 years, with battery or Power-Over-Mbus.

The use of external main power supply will not be acceptable.

G. The meter should have a high-resolution value for energy (0,1 Wh / 1 Wh) and volume (0.00001m³) with min. 10 digits available over M-Bus

H. All supplied meters for all sizes shall have a minimum dynamic range of 1:100 and shall be sized based on nominal flow and not peak flow. An independent approval authority complying to the EN standards shall certify the meters dynamic range.

I. Each tenanted flat shall be fitted with a suitable flow sensor; integrator/calculator and factory calibrated high accuracy temperature sensors and wells. The accuracy of the meter readings to comply EN1434-Class2

J. The suitable flow sensor shall be installed on the return side.

K. The meter shall provide Memory storage facility to store 'Monthly Energy Readings'.

L. The batteries shall be replaceable at site.

The residential meters shall display the battery discharge status and indicate the battery replacement date.

M. The BTU meter shall be tested and approved as a complete hybrid or split meter as per the EN1434 class 2 which consists of the following: energy meter Integrator/calculator, flow sensor, and paired temperature sensors

N. The meter manufacturer shall provide the most recent calibration test report from the factory

O. The time resolution shall be freely selectable and should be able to update data at intervals of minimum every 15minute, however the data shall be update on an hourly basis. The meter data shall automatically be read and stored in the computer for a period of 24 months.

P. The meter should to have the Metrological logbook according to PTB requirements 50.7.

**1.01 FLOW SENSOR**

The ultrasonic technology of the flow sensor has to provide very high measuring accuracy. It shall allow its Installation in return line. The volume-measuring component must conform to the requirements of EN 1434 Class 2.

A. Ultrasonic flow sensor

1. The maximum flow rate (Qs) shall be twice the permanent flow rates (Qp) for all sizes

2. The flow sensor shall not contain any mechanical moving parts

3. The reflectors in the flow sensor shall be full metal

4. The flow part shall a full metal design with appropriate technology to ensure a good longtime accuracy.

5. Flow sensor shall be insensitive to dirt particles

6. Design shall secure that only correct ultrasonic signals passing through the measuring tube are measured (ID be certified by independent authority)

7. Metrological dynamic range (qi : qp) 1:100 for all sizes and flow rates (to be certified by approval)

8. To be approved according to EN 1434 class 2

9. Approval test certificate to be sent along with technical data

10. Cable length between calculator and flow sensor 1.5m

11. Mounting of the flow sensor in any installation position

12. Temperature range: 5°C to 105°C

13. Protection class for flow sensor shall be minimum IP65. However, in certain applications, the flow sensor and the calculator should be available as IP68 option.

14. Air In the pipe shall not be measured

15. Pressure rate of PN 16 shall be available in threaded and PN 25 shall be available in flanged version.

**1.02 INTEGRATOR/CALCULATOR**

A. The integrator/calculator shall contain all the necessary circuits for recording the flow rate and temperature and for calculating, logging and local display of the data.

B. It is recommended for the calculator to be mounted away from the flow part on a support or on the wall.

C. The meter shall allow conveniently reading from a single line LCD 8-digits display plus units and symbols.

D. All failures and faults; shall be recorded automatically and shown on the LCD display. i.e. backflows/Air gaps.

E. In order to protect the reading data, all the relevant data shall be stored in a non-volatile backup memory. This memory shall save the measured values, device parameters and types of error.

F. The integrator/calculator shall be equipped as standard with EN 62056-21 optical Interface with the M-Bus protocol as per EN 1434. This interface might be used for; communication with the adequate software for parameterization and single read out. The integrator/calculator shall provide plug and play communication modules.

G. Temperature Range: 0-180°C

H. Temperature Difference: 3K-120K

I. Operation threshold for ΔT 0.2 K

J. The meter should be operational for a minimum 16 years, with battery or Power-Over-Mbus.

The use of external main power supply will not be acceptable.

K. To be approved according EN1434 class 2

L. The calculator for residential meters shall have the capability to upgrade the firmware at site, without the need to remove the meter from site.

M. The 'Monthly meter reading' shall be stored in the Memory storage of the energy meter integrator/calculator.

**1.03 MODULAR CONCEPT FOR FUTURE INTEGRATION OF OPTIONAL MODULES**

A. The system shall be Plug & Play modules (with a minimum of 1 available slot in the calculator), the modules function shall automatically be set upon Installation.

B. MBUS module with an option of accepting Power-over-M-BUS

C. Radio module (Real Data) transferring of a complete radio protocol, free selectable radio protocol.

**1.04 TEMPERATURE SENSOR**

PT500 as per EN 60751, 2-wire, Diameter 5.2 mm as a minimum (type PS Pocket Sensor and type OS Direct Sensor), cable length 1.5 m as a minimum (PT5OO, type PS and DS) & shall be used.

Technical characteristics of PT5OO:

1. Platinum-Chip temperature sensor according to EN 60751

2. Temperature range: 0 ... +105°C (150°C)

3. Tolerance class B (in K): ± (0.30 K + 0.005 x | t |)

4. Current to be measured 0.15 mA for PT500 recommended

5. Maximum current 3.0 mA

6. Temperature coefficient: 0 = 3,850 x 10-3°C-1(between 0°C and 100°C)

7. Long term stability max. RO -drift: 0, 05%/year

8. Resistance of the isolation > 10M at room temperature

END OF SECTION

# SECTION 06

# DUCTWORK AND AIRSIDE EQUIPMENT

**SECTION - 06**

**DUCTWORK AND AIRSIDE EQUIPMENT**

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## 1.0 SCOPE OF WORK

1.1 Make all ductwork, unless specifically noted otherwise, of galvanized sheet steel conforming to BS 2989 or ASTM A653A, 653M, G90 (Z275) and having a nominal coating of 1.25 oz./sq. ft. The galvanizing shall be carefully done and the sheets shall be of such quality that they may be bent flat on themselves with no fracture to the coating or the base metal.

1.2 Flexible ductwork shall be lightweight aluminium laminated duct suitable for low and medium pressure systems. The aluminium laminated construction shall encapsulate a high tensile steel wire helix between two layers of 0.9-micron thick aluminium plus 12 micron thick polyester. Flexible ducts shall be with factory applied thermal insulation and vapor barrier. Insulation shall be 25mm thick, 16 kg/$m^3$ density.

1.3 All supports, stiffeners, flanges etc. used in ductwork construction and installation shall be hot dip galvanized.

## 2.0 DUCTWORK SPECIFICATION

2.1 Ductwork fabrication and hanging methods shall be as described in the "Equipment" Volume of the American Society of Heating, Refrigerating and Air Conditioning Engineers Guide and Data Book, latest edition, and/or current edition of applicable manuals published by the Sheet Metal and Air Conditioning Contractors National Association Inc., where methods described in these volumes are not at variance with the requirements of any authority having jurisdiction, or do not conflict with methods described hereafter. Ductwork shall not be shop fabricated until work has been job measured and interference situations coordinated.

## 3.0 DUCTWORK GENERAL

3.1 All dimensions shall be checked on site before ductwork manufacture is commenced.

3.2 No ductwork shall touch the building structure or building finishes direct, but shall be isolated with insulating spacer.

3.3 The fabrication shall be carried out in a neat and workmanlike manner with all ductwork true in size and cross-section, braced and stiffened as specified and with all internal and external surfaces free from projections and sharp edges.

3.4 Ductwork shall be rigidly suspended or supported from structure. Expansion type concrete inserts shall be placed so that the fastener is in shear rather than tension. Powder actuated fasteners placed by an explosive charge will not be accepted. Angle type trapeze hangers with rod supports spaced at 2 meters maximum shall be used. "C" type beam clamps will not be accepted. Provide necessary steel angle iron required for bracing of ductwork or equipment, and for supporting ductwork from building structure.

A layer of felt strip 12.5 mm compressed thickness shall be provided between any support member which is designed to clamp or grip the duct (e.g. circular duct band clip) or on which the duct is to rest. All supports shall be hot dip galvanized.

3.5 All necessary allowances and provisions shall be made in the installation of the ducts for the structural framing of the building and when changes or offsets are necessary, the required cross-sectional areas shall be maintained. All of these changes however, shall be approved, and installed as directed at the time.

3.6 During installation the open ends of ducts shall be protected with blank, flanged sheet metal baffles, securely attached to prevent debris and dirt from entering.

3.7 All air ducts, casings, plenums etc., shall be constructed of lock forming quality prime galvanized steel sheets, which are free from blisters, slivers, pits, imperfectly coated spots etc. No second quality sheet metal allowed.

Where damage (or rusting) has occurred on galvanized duct work the affected section shall be made good by painting with two coats of zinc-rich paint and approved finishing paint, or where the damage in the Consultant's opinion cannot be made good, then a new section of ductwork shall be provided at no cost to the contract.

3.8 Ensure that all openings required through floors, walls, partitions etc., for the duct system are provided in the exact location required.

3.9 Each piece of ductwork shall be wiped inside and out before installation and all open ends shall be capped and sealed to prevent entrance of dirt during construction. Ensure that ductwork systems are clean and free from dirt, dust, grime, debris etc., before initial operation of fans. Fans shall not be operated until the filters are installed and approval from the Consultant has been obtained.

3.10 The bottom joint and 150 mm of vertical joint on outside air intake ducts and m1x1ng chamber ducts shall be soldered and made watertight. Provide drain connection and run copper drain pipe to nearest floor drain.

3.11 All fixing devices including nuts, bolts, washers etc., used in the construction or support of galvanized ductwork shall be Sheradised, or cadmium-plated.

3.12 Final connections to diffusers with in offices shall be carried out using flexible and plenum boxes.

**4.0 LOW PRESSURE DUCTWORK**

4.1 This applies to ductwork with mean velocities less than 2,000 fpm (10 M/Sec) and static pressures of 2 inches water gauge, (500 pascals) or less.

4.2 Low pressure suction and discharge plenum chambers shall be fabricated from 1.3 mm (18 gauge) galvanized steel with galvanized angle iron framework and bracing.

4.3 In square elbows and in elbows where radius is less than 1-1/2 x width of duct, sheet metal deflector vanes shall be installed the full height of the duct, being securely riveted in place. All vanes shall be double thickness vanes of two gauges heavier than the duct in which they are installed, and shall be factory made, not site fabricated. Vanes shall be tack welded to vane rail. For vane lengths over 1000 mm, tack weld vanes to 10 mm tie-rod at mid-span.

**5.0 FLEXIBLE DUCT WORK - LOW PRESSURE**

5.1 Flexible ductwork shall be manufactured with a two layer aluminized polyester inner core, surrounded by 25 mm thickness of 24 $Kg/m^3$ density fiberglass, all wrapped in a reinforced multilayer aluminium polyester outer jacket.

5.2 Duct clamps shall be made of an 8mm wide stainless-steel band with 'Lifted' edges to avoid damage to the duct. The clamp shall be provided with a 'flip up' and 'quick lock'.

5.3 Flexible duct installation shall be in accordance with manufacture's instruction. Joints between factory insulated flexible ducts and field insulated ductwork shall be sealed and taped under this section.

**6.0 FLEXIBLE CONNECTION**

6.1 The material shall also be impervious to moisture, dimensionally stable, and shall not rot.

**7.0 BALANCING DAMPERS**

7.1 Install volume control dampers in accessible locations at all branch connections and wherever necessary to adjust the flow of air to secure correct distribution. Casing and blades shall be made of galvanized sheet metal, and shall be equipped with an approved device for fastening in any desired position. This device shall be such that the damper cannot move or rattle and pointer shall indicate the position of the damper from the outside of the finished duct insulation.

7.2 Dampers shall be aero foil multileaf opposed blade with blade height not more than 180 mm.

7.3 All blades shall be operated by a single operating quadrant with gears and links as necessary.

The whole damper assembly shall be mounted in a galvanized frame with flanges.

## 8.0 VIBRATION ISOLATION

8.1 All equipment shall be isolated from the building structure in such a manner that noise and vibration is not transmitted through the structure.

Anti - vibration equipment shall comply with Seismic code for zone 2A.

8.2 Condensing Units

Condensing units shall be supported on spring isolators with minimum 50mm deflection and an isolation efficiency of 99%.

## 9.0 DIFFUSERS AND REGISTERS

9.1 Diffusers, registers and grilles shall be arranged for flush mounting in lay-in type ceilings and overlap mounting in plaster, mineral tile and similar ceilings, with concealed fixings unless otherwise directed.

9.2 Grilles, register and diffuser locations shall be adjusted to suit reflected ceiling drawings, or Consultant's site instructions. All grilles, registers, diffusers, louvers shall be from one manufacturer.

9.3 All diffusers, grilles and registers shall be supplied completely factory powder coated. Finish colour shall be to the approval of the Architect. The interior of all grilles and diffusers is to be factory painted matt black.

9.4 Unless otherwise specified basic grilles and diffuser materials shall be Aluminium extruded sections. Sections in the airstream shall be carefully selected to minimize turbulence. Grilles/diffusers within operating theaters shall be stainless steel construction.

9.5 Ceiling Diffusers shall be multicone giving 4 way horizontal discharge.

9.6 Wall registers shall be double deflection fabricated from aluminium, the front vanes being horizontal, the rear vanes vertical. This grille shall be complete with an opposed blade damper painted matt black and adjustable from the face of the diffuser.

Both sets of vanes shall be fully adjustable without the use of special tools.

## 10.0 EXTRACT AIR LOUVRES

10.1 Louvers shall be extruded Aluminium frame with Aluminium blades of not less than 2 mm thickness, and shall be firmly fixed so as not to vibrate. Behind each louver shall be an insect mesh screen 76 x 6 mm made from 2 mm diameter wire. The screen will be clamped by a 20 mm frame and will be firmly fixed to the outer edges of the louver. The screen and frame shall be hot dip galvanized after fabrication.

10.2 The connection to the louver shall be flexible and shall ensure no duct load is transmitted to the louver.

10.3 Louvers shall be provided with powder coated finish to the approval of the Architect.

## 11.0 SAND TRAP LOUVRE FOR AIR INTAKE

11.1 Sand trap louvers shall have a double deflection inlet passage to separate sand from incoming air by means of centrifugal forces.

11.2 Separation efficiency particle size 350-700 shall not be less than 90% at a face velocity of 1M/Sec and not less than 70% at a face velocity of 2M/sec.

11.3 Sand trap louver shall be of aluminium construction, self-cleaning and maintenance free. The base of the louver shall have self-emptying sand holes.

11.4 Pressure drop at 2 M/Sec average face velocity shall not exceed 120 pascals.

11.5 Insect mesh shall be included.

11.6 Sand louvers shall be provided with powder coated finish to the approval of the Architect.

## 12.0 SUBMISSIONS

12.1 Technical Submissions

For any minor revisions in architectural layouts, contractor shall be responsible to carry out part redesign for such area and submit necessary calculations for Engineer's approval before proceeding with the shop drawings.

12.2 Hardware Submissions

The Contractor will submit catalogue information for all distribution equipment including, but not limited to:-

Duct work - Low pressure.

Flexible duct work - Low pressure Flexible connections.

Balancing dampers.

Vibration isolators.

Diffusers, grilles and registers.

Louvers, Sand louvers.

Filters.

12.3 The Contractor will submit samples for any or all of the above as requested by the Consultant after receipt of the catalogues.

12.4 Samples will definitely be required of these items which are exposed, such as diffusers, grilles, louvers. The samples must be of size, specification and finish to be relevant to the project.

12.5 Where a Country of Origin is given, this refers to the Head Office in the case of International Corporations. However, for each product not manufactured in that Country, separate approval must be obtained from the Consultant.

## 13.0 DUCT THERMAL INSULATION

1.01 Work Included

A. Supply all labor, materials, tools and equipment for installing thermal Insulation on HVAC ducts to the required SMACNA / NAIMA / ASHRAE standards and subject to the terms and conditions of the contract document.

1.02 Product Description :

Self-sealing Glass wool board insulation with Alu glass facing & of a minimum core density of 48 Kg/m³ stuck on GI ducts.

1.03 Quality Assurance.

A. The self-Sealing glass wool board insulation to be manufactured at the manufacturer's facility conforming to the various quality standards like ISO 9001-2008 and with a minimum experience of 20 years in manufacturing Glass wool insulation products.
B. ***MANDATORY Product conformity test certificate*** from Dubai Central Laboratory / DM.

C. **Physical Characteristics**: Self Seal Glass wool board insulation shall have

1. Self-sealglass wool board insulation shall have a peel and stick adhesive backing.
2. Self-Seal glass wool board insulation shall have an Alu Glass facing of minimum foil thickness of **180-200 microns**
3. The Self seal insulation shall have a thickness not less than 25 mm for Internal and 50mm for external /exposed ducts.
4. Compression strength: ≥ 1.2 kPa @ 10 % deformation.
5. Thermal Conductivity: Self Seal Glass Wool board ducts shall have a thermal conductivity less than 0.032 W/mK @ 25 °C mean temp As per BS / ASTM / ISO & DIN standards.
6. Water Vapor absorption: Less than 1 % by Volume.
7. Water Vapor transmission for the facing as per ASTM E96 to be "0.00"
8. Aging test certificate issued by an independent third party laboratory to be submitted for review.
9. Aluminum cladding to be done on external/exposed ducts.

D. Corrosion: The Self Seal glass Wool board insulation shall not be corrosive to steel.

E. Fire properties :

1. It is mandatory for Base fiber to be rated as NON COMBUSTIBLE when tested in accordance with ASTME 136 or BS 476 part 4 test method.
2. The composite product tested with Alu Foil and Adhesive backing tested in accordance with ASTME 84 test standards for surface building characteristics of Building material shall exhibit a **minimumFSI ≤ 25 and SDI ≤**5. The time to ignition should be more than 20 SECS (time less than 20 secs is not acceptable). The report should report and mention time to Flaming droplets in the report (product exhibiting flaming droplets during the test are not acceptable).

3. The product shall be tested in accordance with EN 13501 – 1 fire test method andhave a minimum rating of Fire behavior – B, Smoke developed – s1 and Flaming droplets – d0.

***F.*** Green Building Compliance: The product should comply to QSA, LEED, Estidama ratings, ***Dubai Green Building regulation and specification as per Clause 701.01 (1)***

1.04Submittals

A. Submit product data.
   1. Catalogue sheet.
   2. Company profile.
   3. Test reports (thermal conductivity, Fire test, LEED).
   4. List of referenced projects.
   5. Manufacturer's method statement for installation.
   6. VOC reports.

3.01 Installation

A. General

Install work in accordance with the manufacturer's approved product installation procedures.

**REFERENCES**

American Society for Testing and Materials International, (ASTM)

- ASTM C411: Test Method for Hot-Surface Performance of thermal insulation.
- ASTM C547: Specification for Mineral Fiber Pipe Insulation.
- ASTM C612: Specification for Mineral Fiber Board Thermal Insulation.
- ASTM E84: Standard Test method for surface burning characterising.
  British & European Standards BS – EN standards.

- BS 476 PART 6: Fire propagation test
- BS 476 PART 7: Surface spread of flame
- EN 13501 -1: European standard for fire classification

**DELIVERY, STORAGE AND HANDLING**

- Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- Protect from weather and construction traffic.
- Protect against damage from any source.
- Store at temperatures and conditions recommended by manufacturer.

– End of Section –

**SECTION 07**
**FIRE FIGHTING SYSTEM**

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**GENERAL**

## A. CONTRACTORS RESPONSIBILITIES

The Contractor is responsible for the quality and the satisfactory operation of the installations entrusted to him, as well as for compliance with the performance stipulated in this document. Consequently, for his own account and under his own responsibility, he must carry out all calculations and select the necessary materials and equipment.
Apart from the required performance definitions, this document and the relevant drawings also provide many indications resulting from the studies carried out by the Engineer.
The Contractor shall review these studies and check the corresponding indications. The same applies to equipment selection, for which the information given in this
document must be deemed as indicative and defines only the minimum requirements.

## B. SCOPE DESCRIPTION

The contractor shall furnish all labor, materials, tools, supplies, equipment, transportation, supervision, technical, professional and other services, and shall perform all operations necessary and required to satisfactorily complete all the necessary engineering, procurement services, construction work and commissioning for the fire protection systems and equipment's for the project.

## C. BASIC DESIGN CRITERIA

Refer tender Drawings and Documents. D.
CODES AND STANDARDS
All the systems shall be designed and installed in accordance with the requirement of International Codes and Standards and Local Authority having Jurisdiction. They shall be particularly in accordance with the following NFPA /BS EN/Vds standards:

- NFPA 10, Standard for Installation of Portable Fire Extinguishers
- NFPA 11, Standard for the low, medium and high expansion foam
- NFPA 11A, Standard for low, medium and high expansion foam system
- NFPA 12, Standard for carbon dioxide extinguishing system
- NFPA 13, Standard for the Installation of Sprinkler Systems
- NFPA 14, Standard for the Installation of Standpipe and Hose Systems
- NFPA 15, Standard for water spray fixed system for fire protection
- NFPA 17, Standard for dry chemical extinguishing systems
- NFPA 17A, Standard for wet chemical extinguishing systems
- NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection
- NFPA 22, Standard for Water Tanks for Private Fire Protection
- NFPA 24, Standard for the Installation of Private Fire Service Mains and their Appurtenance
- NFPA-25, Standard for Inspection, Testing, and Maintenance of Water Based Fire Protection Systems
- NFPA-70, National Electric Code
- NFPA 72, National Fire Alarm Code
- NFPA 92A, Standard for Smoke Control System
- NFPA-101, Life Safety Code

NFPA-110, Standard for Emergency and Stand by Power systems
NFPA-170, Standard for Fire Safety Symbols
NFPA 204, Standard for Smoke and Heat Venting
NFPA-220, Standard for types of Building Construction
NFPA-221, Standard for Fire Walls and Fire Barrier Walls
NFPA 780, Standard for the Installation Lightning Protection Systems
NFPA-2001, Standard on Clean Agent Fire Extinguishing systems
NFPA 5000, Building Construction & Safety Code
OSHA, Code of federal regulations, Title 29, Part 1926
BS EN3 for portable fire extinguishers
BS EN 1866 for mobile extinguishers
BS EN 671-1 for fixed firefighting system
BS 5041-3 for dry riser inlet
BS EN 54 Standard for installation of Fire Alarm System.

## E. SCOPE OF WORK

This specification covers the supply, delivery and complete installation on site and in full working order of the equipment specified in this document and/or shown on the drawing
Full particulars, performance curves and illustrations of the equipment, complying as closely as possible with this specification, shall be provided with the tender, but any deviations from the specification must be fully and clearly indicated in the tender submission schedules.

The Contractor shall provide and install:

- The complete fire pumping station, including the firewater pumps (pumps, diesel engines drive, pump controllers, skid & pump), the jockey pump (pumps, electric drive, electric drive controllers), the piping & hanging, the valves, check-valves, relief valves, fittings, the instrumentation, the storage fire water tanks and feeding controllers (valves & controllers).
- The firewater mains (sprinkler, standpipe & hydrant), including the piping, the fittings, the hanging, the block-valves & the hydrants.
- The wet sprinkler systems, including the control valves, the piping, the hanging, the heads, the instrumentation.
- The hose reels (standpipes, hose connections, external hose streams).
- The portable extinguishers
- Clean agent fire suppression system for the rooms mentioned in the drawings.
- The marking of all the safety equipment

The Contractor shall be responsible for all the following aspects of the provided systems:

- The checking of the tender drawings and any calculations supplied with the drawings. The Contractor shall check each drawing and satisfy himself that the design is correct for the equipment offered and will meet all applicable rules and Local Authority regulations
- The provision of any additional information required by the Contractor's installation engineers who are particular to the equipment being supplied e.g. fabrication drawings, equipment data sheets, commissioning instructions etc.
- The provision of drawings and equipment data related to the systems as required by the Engineer.

- The supply of all required equipment and other fixtures associated with the systems
- testing of equipment and provision of inspection facilities.
- The supply of as built drawings
- A demonstration to key personnel in the use and testing of the systems and equipment supplied.
- Operating and maintenance manuals.

**F. MATERIALS**

The Contractor shall supply all materials necessary to make up effective and operable fire protection, detection and alarm systems, voice alarm system and emergency & exit lighting systems for the facilities indicated in the drawings and in the present specification, and particularly:

- All the necessary pipe work, valves, equipment and instrumentation required for the facilities
- All electrical cable between panels, junction boxes, sensors, call points, pressure switches, alarm bells, flashing lights, and generally all the cable (and their supports) required for the facilities.
- Local alarms indicating actuation of the systems
- All detectors, fire signaling and alarm cabling shall be installed by the Contractor using materials in accordance with international standards.
- All emergency lights, exit lights with directional arrow marks & pictograms as required, central battery panels, addressable monitoring panel, interface modules, phase monitoring relays and interconnecting cabling shall be installed by the contractor using the materials in accordance with International standards.

The main electrical supply to the Contractor's equipment will be by others.
All instrumentation and electrical equipment will be enclosed to suit the Hazard Class of the area.
The Hazard Class of each area is indicated on the Hazardous Area Layouts.
Hazardous Area Certificate will be required for each item supplied within the Hazardous Area.

**G. QUALITY OF MATERIALS**

Only materials meeting quality guidelines mentioned specifically for the products shall be subject to the approval of the Authorized Engineer.
Wherever applicable, the system and material is to comply with the relevant International Standards or British Standards /Vds /LPCB.
All Materials should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB/ BSI Kitemark /Vds and or UL/FM.

**H. APPROVAL LISTING OF MATERIALS**

The equipment shall have been tested and, where applicable, shall have been granted a certificate of approval or listing for the intended service. UL listed, FM approved, BSI Kitemark, LPCB, Vds approved equipment shall be used where possible. Where equipment is offered without the above

approval or listing, these items shall be listed with the type of certificate or approval granted indicated.
The Contractor shall supply only proven and established equipment which is suitable for the duty. The Employer reserves the right to call for either substitute or alternative units, or to nominate manufacturers or models for any class of equipment.

## I. SUBMITTALS

The installing contractor shall submit the following design information and drawing for approval prior to starting work on this project.

## J. PRODUCT DATA: SUBMIT MANUFACTURERS TECHNICAL PRODUCT

Field installation layout drawings having a scale of not less than (1:100m) detailing the location of all equipment's, pipe runs including pipe sizes and lengths, controls and other accessories.
Auxiliary details and information such as maintenance panels, door holders, special sealing requirements and equipment shutdown.
Separate layouts, or drawings, shall be provided for each floor plans (i.e.; sectional drawings, raised floor drawings, and above false ceiling drawings) for mechanical and electrical work.
A separate layout or drawing, shall show isometric details of clean agent storage containers, mounting details and proposed pipe runs and sizes.
Electrical layout drawings shall show the location of all devices and include point-to- point conduit runs and a description of the method(s) used for detector mounting.
A complete sequence of operation shall be submitted detailing all alarm devices, shutdown functions, remote signaling, and agent discharge for each system.
Submit drawings, calculations and system component data sheets for approval to the local Fire Prevention Agency, and all other Authorities Having Jurisdiction before starting installation. Submit approved plans to the Architect/Engineer for record.

## K. SHOP DRAWINGS

The Sub-Contractor shall provide shop drawings for each system floor wise in detail as required by the engineer in charge and Authority having jurisdiction. It is the contractor responsibility to co-ordinate with other services while preparing the shop drawings and obtain approval from the engineer in charge.

## L. AS BUILT DRAWINGS

Upon completion of each system, the installing contractor shall provide four (4) copies of system "As-Built" drawings to the owner. The drawings shall show actual installation details including all equipment locations as well as piping and conduit routing details. Show all room or facilities modifications, including door and/or damper installations completed. One (1) copy of reproducible engineering drawings shall be provided reflecting all actual installation details.
These drawings shall be as accurate and complete as possible.

## M. COMMISSIONING AND TESTING

Performance tests shall be carried out at site in the presence of Civil Defense personnel.

All tests shall be carried out in the presence of the Employer's, insurers or their nominated representatives.
The Contractor shall provide all the necessary tools and equipment for testing and commissioning activities.

## I. FIRE FIGHTING

FIRST AID EQUIPMENTS
All First Aid Equipment's (Fire Extinguishers, Hose Reels, Fire Hose Fire blankets) shall have been certified by two Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB Approval / BSI KITE mark approval and or UL listed/FM Approved.

### A. FIRE EXTINGUISHERS

### B. GENERAL:

- Fire Extinguishers shall be manufactured to comply with BS EN 3 (portable), BS EN 1866 (Mobile) standards.
- Fire Extinguishers shall comply with NFPA-10 or BS 5306 for the installation.
- The classification of fire extinguishers shall consist of a letter that indicates the class of fire on which a fire extinguisher has been found to be effective, preceded by a rating number (Class A, Class B and Class F only) that indicates the relative extinguishing effectiveness.
- The distribution of fire extinguishers shall comply with the prescribed requirements of NFPA-10, as shown on the drawings and the specific requirements of the local Civil Defense Authorities.
- Cabinets housing fire extinguishers shall not be locked.
- Portable fire extinguishers shall be maintained in a fully charged and operable condition, and kept in their designated places at all times when they are not being used.

### C. DEFINITIONS

- The type of extinguisher needed depends on the right type of fire that may occur in the room or building.
- According to NFPA 10, several classes of fire have been defined:

I. Class A Fires: Fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics.
II. Class B Fires: Fires in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.
III. Class C Fires: fires that involve energized electrical equipment where the electrical non-conductivity of the extinguishing media is of importance. (Where electrical equipment is de-energized, fire extinguishers for class A or B fires can be used safely.)
IV. Class D Fires: Fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium.
V. Class K or Class F Fires: Fires in cooking appliances that involve combustible cooking media (vegetable or animal oils and fats.)

a) Building presenting class B or C fire hazard shall be equipped with a regular number of class A extinguishers dedicated to the building protection, and shall also be equipped with adding class B or C extinguishers.

b) According to these definitions, all parts of the buildings shall be equipped with class ABC type extinguishers. In the meantime, rooms such as Storages, Workshops and other rooms housing electrical equipment's, shall be equipped with adding class C
extinguishers.

**D. DRY POWDER FIRE EXTINGUISHER:**

Dry powder fire extinguishers shall be manufactured in accordance with BS EN3
for portable extinguishers and BS1866 for mobile extinguishers and shall be operated by means of a lever/squeeze handle operated valve provided with a safety pin which shall avoid inadvertent operation and the valve shall be capable for controlling partial discharge. The cylinder shall have minimum working pressure of 14bar. The temperature shall range from -20° to 60° C. It must be coated externally by electrostatic polyester powder and oven baked for corrosion resistance. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 automatic welding process and the suction tube shall be made of PVC material. All extinguishers shall carry instructions for operation and maintenance in English and Arabic.

The product should have at least been certified by two Independent Certification Organizations from the International Testing Laboratories & Accredited Certification Bodies as LPCB Approval/BSI Kitemark Approval

The extinguishers are recommended with the capacities and minimum fire rating as follows:

| SL # | Description | Capacity | Fire Rating |
|---|---|---|---|
| 1 | Dry Powder Fire Extinguisher | 2 kg | 89B |
| 2 | Dry Powder Fire Extinguisher | 4 kg | 113B |
| 3 | Dry Powder Fire Extinguisher | 6 kg | 183B |
| 4 | Dry Powder Fire Extinguisher | 9 kg | 233B |
| 5 | Dry Powder Fire Extinguisher | 12 kg | 233B |
| 6 | Dry Powder Mobile | 25 kg | IIB |
| 7 | Dry Powder Mobile | 50 kg | IVB |
| 8 | Dry Powder Mobile | 100 kg | IVB |

**E. CARBON DIOXIDE FIRE EXTINGUISHER:**

Carbon dioxide fire extinguishers shall be manufactured in accordance with BS EN 3 (portable) and BS EN 1866 (mobile) and shall be operated by means of a lever /squeeze handle operated valve provided with a safety pin which shall avoid inadvertent operation and the valve shall be capable for controlling partial discharge. The cylinder shall be made of high-grade carbon steel pipe or aluminum alloy and It must be coated externally by electrostatic polyester powder quoting and oven baking to resist corrosion. The cylinders shall be free from leakage during hydrostatically pressure tested to 250 bar. The temperature shall range from -20° to 60° C.
The suction tube shall be Aluminum. All extinguishers shall carry instructions for operation and maintenance in English and Arabic.

Typical applications are electrical & electronic equipment's, food preparation areas, laboratories, and printing or duplicating areas, telephone equipment Rooms, Engine Rooms, Control Rooms, Paint spray Booths, Flammable liquid storage areas etc., Since the agent is discharged in the form of a gas/snow cloud, it has a range of 4m – 6m This type of fire extinguisher is not recommended for outdoor use where windy conditions prevail, or for indoor use in locations that are subject to strong air currents because the agent can rapidly dissipate and prevent extinguishment. The concentration needed for fire extinguishment reduces the amount of oxygen (air) needed for life safety when the discharge is in a confined area (space).

The Carbon dioxide fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories
& Accredited Certification Bodies as LPCB approval/KITE mark approval and

The CO2 extinguishers are recommended with the capacities and minimum fire rating as follows:

| SL # | Capacity | Fire Rating |
|---|---|---|
| 1 | 2 Kg $CO_2$ Extinguisher | 34B |
| 2 | 5 Kg $CO_2$ Extinguisher | 55B |
| 3 | 10Kg $CO_2$ Mobile Extinguisher | 70B |
| 4 | 30kg $CO_2$ Mobile Extinguisher | 113B |

## F. WATER FIRE EXTINGUISHER (FIRST AID EQUIPMENT)

Water type Fire extinguisher shall manufacture in accordance to BS EN 3 (portable) and shall be operated by means of a lever operated self-closing control valve to enable the discharge to be interrupted temporarily and provided with a safety pin. The cylinder shall have minimum working pressure of 14bar. The temperature shall range from +5° to 60°C. The extinguisher must have a plastic base. It must be coated inside by electrostatic PVC resin to resist corrosion. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 welding process and the suction tube shall be made of Rigid PVC with filter. The water type fire extinguisher capacity shall be of minimum 6 ltrs stored pressure type. All extinguishers shall carry instructions for use in English and Arabic.

The capacity of the extinguisher shall be of minimum 6 ltrs shall have a minimum fire rating of 13A as per BS EN3.
The water extinguishers are recommended with the capacities and minimum fire rating as follows:

| SL # | Capacity | Fire Rating |
|---|---|---|
| 1 | 6 ltr Water | 13A |
| 2 | 9 ltr Water | 21A |

The water type fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/KITE mark approval

**G. FOAM FIRE EXTINGUISHER:**

Foam type Fire extinguisher shall manufacture in accordance to BS EN 3 (portable) and BS EN 1866 (mobile) and shall be operated by means of a lever operated self-closing control valve to enable the discharge to be interrupted temporarily and provided with a safety pin. The cylinder shall have working pressure of 14 bar. The temperature shall range from +5° to 60°C. The extinguisher must have a plastic base. It must be coated inside by electrostatic PVC resin to resist corrosion. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 welding process and the suction tube shall be made of Rigid PVC with filter. The Foam type fire extinguisher minimum capacity shall be of 6 ltrs stored pressure type. All extinguishers shall carry instructions for use in English and Arabic.

The minimum capacity of the extinguisher shall be of 6 ltrs shall have a minimum fire rating of 21A 144B as per BS EN3.

The Foam extinguishers are recommended with the capacities and fire rating as follows:

| SL # | Capacity | Fire Rating |
|---|---|---|
| 1 | 6 ltr Foam | 21 A & 144B |
| 2 | 9 ltr Foam | 21A & 183B |
| 3 | 50Liter Foam Mobile | IVB |
| 4 | 100Liter Foam Mobile | IVB |
| 5 | 135Liter Foam Mobile | IVB |

The Foam type fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/KITE mark approval.

**H. WET CHEMICAL FIRE EXTINGUISHER:**

The Wet Chemical Fire Extinguishers shall have LPCB Approved /BSI KITE mark approved and comply with BS EN3 standards. The cylinder shall be tested to 30 bar and shall have minimum pressure of 10 bar. The capacity shall be of 3 liters 8A25F & 6 liters with 13A75F ratings. They shall be provided in all the kitchens. The temperature shall range from +5° to 60°C.

The Wet Chemical extinguishers are recommended with the capacities and fire rating as follows:

| SL # | Capacity | Fire Rating |
|---|---|---|
| 1 | 2 ltr Wet Chemical | 5F |
| 2 | 3 ltr Wet Chemical | 8A25F |
| 3 | 6 ltr Wet Chemical | 13A75F |

The Wet chemical type fire extinguishers: The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/KITE mark approval

**I. CLEAN AGENT FIRE EXTINGUISHER: (FIRST AID EQUIPMENT)**

Clean Agent Fire extinguisher shall have LPCB Approved and manufactured in accordance to BS EN3 (portable)and shall be operated by means of a Squeeze/ lever operated self-closing control valve to enable the discharge to be interrupted temporarily and provided with a safety pin. The cylinders shall be tested to 30 bar and shall have working pressure of 15 bar. The temperature shall range from -20° to 60°C. The extinguisher must have a plastic base. The cylinder shall be made special cold rolled steel sheet with Argon/CO2 welding process and the suction tube shall be made of Rigid PVC with filter. The Clean Agent type fire extinguisher minimum capacity shall be of 4 Kg stored pressure type. All extinguishers shall carry instructions for use in English and Arabic.

The product should have at least been certified by two Independent Certification Organizations from the International Testing Laboratories & Accredited Certification Bodies as LPCB Approval/BSI Kitemark Approval.

The Clean Agent extinguishers are recommended with the capacities and fire rating as follows:

| SL # | Capacity | Fire Rating |
|---|---|---|
| 1 | 4 Kg Clean Agent Extinguisher | 34B C |

| | | |
|---|---|---|
| 2 | 6 Kg Clean Agent Extinguisher | 5A 55B C |
| 3 | 9 Kg Clean Agent Extinguisher | 8A 70B C |
| 4 | 12 Kg Clean Agent Extinguisher | 13A 70B C |

**J. INSTALLATION:**

1. Fire extinguishers shall be conspicuously located where they will be readily accessible and immediately available in the event of fire. Preferably they shall be located along normal paths of travel, including exits from areas.
2. Fire extinguishers shall not be obstructed or obscured from view.
3. Portable fire extinguishers other than wheeled types shall be securely installed on the hanger or in the bracket supplied or placed in cabinets or wall recesses. The hanger or bracket shall be securely and properly anchored to the mounting surface in accordance with the manufacturer's instructions. Wheeled-type fire extinguishers shall be located in a designated location.
4. Fire extinguishers having a gross weight not exceeding 40 lb (18.14 kg) shall be installed so that the top of the fire extinguisher is not more than 5 ft (1.53 m) above the floor. Fire extinguishers having a gross weight greater than 40 lb (18.14 kg) (except wheeled types) shall be so installed that the top of the fire extinguisher is not more than
31/2 ft (1.07 m) above the floor. In no case shall the clearance between the bottom of the fire extinguisher and the floor be less than 4 in. (10.2 cm).
5. Fire extinguishers shall be installed in cabinets where required in finished rooms / office areas and as shown on the drawings and shall be confirmed with the Architect.

**K. FIRE HOSE REELS-AUTOMATIC TYPE.**

The hose reel drum shall be made of electro galvanized steel sheet and the cabinet shall be supported with reinforced support arm and swing through 180 degrees. Welding of any part on cabinet front shall not be allowed. The middle piece of the hose reel shall be not less than 200mm diameter.

The reels shall comply with BS EN 671-1 and comprise a reinforced semi rigid hose. The semi rigid hose use for the hose reel shall be LPCB/BSI Kite mark and or having Local Civil Defense approved in conformance to BS EN 694. The semi rigid hose shall be 25mm 30m long, coiled on a revolving drum. The outer end of a hose shall be fitted with a "jet / spray / shut-off" control nozzle. The inner end of the hose shall be connected through the reel to the water supply.

The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB approval/KITE mark approval. In case of automatic hose reels, the reels shall incorporate a valve that automatically turns on the water supply when approximately 3 mtr of hose is unreeled, and shut off again when the hose is re-wound onto the reel. A Lock Shield type shut off valve shall also be installed on the service pipe to each hose reel.
The hose nozzle shall be (JET/SPRAY/SHUT OFF) type nozzle.
Each hose reel shall be installed and tested to BS EN 671 -1 standards and shall deliver not less than 0.4 l/s when the two top-most reels are in use simultaneously providing a jet of approximately

6 mtr. in length. 25 mm dia Pressure reducing devices shall be provided necessary to limit the pressure as per local authority requirement.

Brief operating instructions should be clearly displayed on or by each hose reel in both English & Arabic languages
The hose reels shall be suitable for working pressures up to 12 bar (175psi) and shall be installed in accordance with the manufacturer's instructions.

**L. FIRE HOSE RACK:**

Fire hose rack assembly shall be UL/FM approved. The hose rack shall be of size of 1.5 inch x 30 mtr or 2.5 inch x 30 mtr.
Brief operating instructions shall be clearly displayed on the unit.
The hose rack assembly shall be semi-automatic type and suitable for the working pressure of 250 psi and shall be installed in accordance with the manufacturer's instructions.
The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as UL and or FM

**M. FIRE BLANKETS:**

Provide fire blankets in Kitchens. Fire blanket shall be good quality with silicone coating provided on both sides. The size shall be 4 feet x 4 feet, 4 Feet x 6 feet and 6 feet x 6 feet. The product should have at least been certified by two independent Certification Organizations from International Testing Laboratories & Accredited Certification Bodies as LPCB/Kitemark approved.

**STANDPIPE AND HOSE SYSTEMS**

**N. FIRE HOSE & NOZZLE:**

Fire hose and nozzles: The product should have at least been certified by two independent certification organizations from international testing laboratories & accredited certification bodies as LPCB approval/BSI kite mark approval or UL listed.
Fire hose shall be of natural rubber lined, 65 mm diameter and 30 m long equipped with aluminium male coupling for the connection with the landing valve, and female coupling for the connection 65 mm chrome plated adjustable diffuser nozzle. The fire hose unit shall include the landing valve and shall have minimum working pressure of 12 bar
Nozzle shall be light weight of aluminum alloy with three operating positions-OFF, STRAIGHT JET and WATER SUPPLY and Kitemark approved.

**O. LANDING VALVES (PRESSURE REDUCING & RESISTING DEVICES)**

Hydrant outlets should be of a type acceptable to the public fire brigade and should comprise a valve 65mm bore constructed in forged brass, threaded for attachment to the riser and fitted with a 65 mm instantaneous female coupling and a blank cap secured by a suitable length of chain. The valve gate should lift clear of the waterway and the valve cover should be securely fitted to the valve body so that it does not unscrew when operated. The valve spindle should not be less than 22 mm diameter and fitted with a hand wheel which should be anti-clockwise. The whole fitting should be of sound construction and shall be suitable for a working pressure of 12 bar. Valve shall UL, FM approved.

Install landing valve in the lower compartment of the fire hose cabinet

**P. HOSE REEL CABINETS:**

Cabinet material should be Either E.G. sheet, Red (RAL 3000) Powder Coated or Stainless steel.
Recessed fire hose cabinet shall be of 1.2 mm thick stainless-steel brush finish front fascia with electro static powder coated painted, to RAL finish back box and to the Architects approval. Cabinets shall be installed as shown in the drawing and where applicable.
Surface mounted fire hose cabinet shall be 1.2 mm thick electro galvanized steel / 1.2 Stainless Steel 304 sheet. Cabinets shall be installed as shown in the drawing and where applicable.
Upper compartment shall accommodate Fire Hose Reel assembly or Fire Hose Rack.
Lower Compartment shall accommodate Fire Hose, Landing valve, Water Branch Pipe & Portable Fire Extinguisher.
Door Type shall be Fire Rated Glass Door.
The Double fire hose reel cabinet in different locations of the building shall have following specified fire equipment's:

(a) Automatic or manual Fire Hose Reel assembly.
(b) Landing Valves, Fire Hose and Nozzle or fire hose rack assembly
(c) $CO_2$ Fire Extinguisher
(d) DCP Fire Extinguisher

**Q. FIRE BREECHING INLET VALVE:**

The Breeching Inlet connection shall be of horizontal pattern having a 100 mm / 150 mm flanged outlet and 65 mm diameter instantaneous male inlets complete with blank caps and chains. A non-return (check) valve shall be provided to protect the inlets. The coupling shall comply with BS 336. The Breeching inlet shall have BSI Kitemark, LPCB approval and shall be housed in a box with wired glass door.

**R. FIRE BREECHING INLET VALVE CABINET:**

Construction material for the Breeching Inlet cabinet shall be stainless steel/ Electro galvanized steel. Breeching inlet location shall be accessible and as per approval of Authority Having Jurisdiction (Dubai Civil Defense).
The breeching piece and drain valve shall be housed in an inlet box with a wired glass fronted door.

(a) Conspicuously indicated by the words: "Dry Riser Inlet, Sprinkler Inlet, and Wet Riser Inlet" in block letters on the inner face of the glass, depending on the project type.
(b) Fastened only by means of a round lock, which can also be operated from the inside without the aid of a key after the glass has been broken.
(c) 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.

**S. EXECUTION/ INSTALLATION.**

Standpipe and hose systems shall be installed in accordance with NFPA-14 and Authority having jurisdiction requirements and as shown on the drawing.

The Fire protection contractor shall be responsible to co-ordinate his work with all other trades and shall be completely familiar with and shall make allowance for conditions which affect the fire protection installation.
The Fire hose cabinets shall be mounted securely in the concrete block walls, shimmying the back box and mortaring tightly in place.
Provide a pressure gauge with an isolation ball valve with inspector's test plug on top and bottom of each stand pipe risers.
Chrome plated nipples shall be provided in between the landing valve and hose connection. Chrome plated escutcheons shall be provided where pipes penetrate the cabinet.
A water flow switch shall be provided in each standpipe riser and interfaced to fire alarm system for monitoring and to locate the section of water flow during firefighting operation.
A drain valve and piping, located at the lowest point of the standpipe piping downstream of the isolation valve, shall be arranged to discharge water at an approved location.

## T. CLEANING AND TESTING

pipes and all items of equipment shall be delivered, stored and maintained in closed storage with their open ends effectively plugged, capped or sealed. All fittings, valves and sundry items shall be stored in clean bins or bagged and stowed in suitable racks. All such stored items shall be maintained under weatherproofed cover to be supplied by the MEP sub-contractor until they are ready for incorporation in the works. Particular care shall be taken to ensure that electrical equipment and components are kept clean and dry.
Before installations are handed over or subjected to the inspection and tests, the entire installation shall be thoroughly cleaned, both internally and externally.
All fire protection installations shall be flushed out with clean water. During the flushing out, provision shall be made to exclude any items of plant, which could be damaged by the cleaning operation. The entire operation shall be carried out to the satisfaction of the Engineer.
The fire protection system shall be tested in accordance with the NFPA codes and the relevant standards, with particular reference the requirements set forth in this section:
All testing shall be performed under the work of this section. All services required for testing shall be a responsibility of the work of this section. The MEP sub-Contractor shall notify the Engineer of all tests, 48 hours prior to testing.
If the systems are tested in sections, the connection to the previously tested section shall be included.
All tests that may be required by the local fire authorities shall be performed under the work of this section, in the presence of their representative, if so required.

All leaks shall be corrected and the system re-tested until no leaks are found, at no cost to the client.
Functional tests of all water flow alarms are a responsibility of the works of this Section. When the various systems are completed, operation tests shall be run on all equipment to demonstrate proper operating conditions. These tests shall be run under the observation of the inspector and the client's operating engineer. The client's operators shall be instructed during this period. Operation tests shall be performed under the work of this section.
Should any piece of equipment or apparatus of any material or work fail in any of these tests, it shall be immediately removed and replaced by a perfect material, and the portion of the work replaces shall again be tested under the work of this Section.

## II. FIRE PUMP SETS

### A. GENERAL

- 1 Electric Main Fire pump
- 1 Diesel Stand By Fire pump
- 1 jockey pump

Each system shall be design to ensure the maximum pumping capacity even if 1 pump fails.
The fire pumps, motor, engine and electric pump controllers and diesel pump controllers shall be UL listed or FM approved, built in the country where the agreement is made.
Unit responsibility must be submitted from the manufacturer.
The fire pumps and engine driven shall be in accordance with NPFA 20 (curves, starting, protection, …).
The contractor shall provide fully certified hydraulic calculations for exact sizing of the pumps.
The pumps shall be furnished with a full set of bench test certificates proving acceptability for the design points of this installation.

### B. PRODUCTS

### C. FIRE PUMPS:

Fire pumps shall be UL or FM approved. Each pump shall have a capacity as shown in pump schedule, adjusted as necessary to suit the hydraulic calculations.
The pumping unit or package shall meet all requirements complying with NFPA 20
The pumps shall also deliver not less than 150% of rated capacity at a pressure of not less than 65% of rated pressure. The shutoff pressure shall not exceed 140% of the rated pressure at rated capacity.

### D. FIRE PUMPS TYPE:

Each fire pump shall be of horizontal split case, centrifugal end suction single stage or multistage construction, specifically labeled for fire service and capable of providing the required flow and pressure of the entire development. The suction supply for the fire pump shall be from a storage tank at a maximum pressure of 20 kPa and a minimum pressure of 0 kPa. The pump casing shall be cast iron and rated to withstand twice the working pressure.

### E. PUMP CONSTRUCTION:

The pump construction shall be cast iron casing, Bronze impeller, Alloy Steel shaft and gland packing.
Note: The pump shall also deliver not less than 150 % of the rated capacity at a pressure of not less than 65 % of the rated pressure. The shut off pressure shall not exceed 140 % of the rated pressure at rated capacity.

### F. PUMP DISCHARGE & HEAD:

The pump discharge & head shown on the drawing schedule is an estimate. The fire protection contractor shall select a pump discharge and head to satisfy the fire protection system requirements resulting from the system hydraulic calculations.

**G. FIRE PUMP ACCESSORIES:**

The Fire and Sprinkler Pumps shall include the following accessories, as required by NFPA standards:

1. Flow Metering Device, shall be of the Venturi type. Pilot and annubar devices will not be acceptable- One metering device shall be provided for each set of pumps. or as shown on the drawings. Test Header return to the storage tank.
2. Air release valve and fittings.
3. Discharge pressure gauge.
4. Main relief valve, pilot operated, (diesel drive only).
5. Main relief valve with discharge pipes to water tank. (Scope of Contractor)
6. Pump casing relief valve for Electric Pump set

**H. ELECTRIC MOTOR DRIVE:**

On installations where the Fire Pump is to be operated electrically, the electric motor shall be a horizontal, open drip-proof type UL listed, wound for 380 V, 3 phases, 50 Hz (cycle) current. The motor shall be of such capacity that 115% of the full-load ampere rating shall not be exceeded at any condition of the pump load for UL Listed fire pump.
With an ambient temperature not exceeding 40 deg. C, the motor shall be designed for a temperature rise not exceeding 50 deg. C when carrying fully rated-load continuously, and shall be capable of operating continuously with an overload of 15% without stress or excessive rise in temperature. The locked rotor current shall not exceed the values specified in NFPA Pamphlet No. 20.

I. ELECTRIC DRIVE CONTROLLER

Automatic Microprocessor electric controller shall be UL listed and FM Approved. The Controller shall be Microprocessor type. It shall be completely assembled, wired and tested by the control manufacturer before shipment from factory, and shall be labeled 'Fire Pump Controller". The controller shall be located as practical and within the sight of the motor.
The controller shall be so located or protected that it will not be injured by water escaping from the pump or connection. The controller shall be of the combined manual and automatic star delta type and shall be complete with:

1. Disconnect switch - externally operable, quick-break type.
2. Circuit breaker - time delay type with trips in all phases set for 300% of the motor full load current-
3. Motor starter, capable of being energized automatically through the pressure switch or manually by means of an externally operable handle. Motor starter shall be of the Wye DeltA
4. Running period timer - set to keep motor in operation, when started automatically, for a minimum run period Timer
5. Pilot lamp - to indicate circuit breaker closed and power available.
6. Alarm relay - to energize an audible or visible alarm through an independent source of power to indicate circuit breaker open or power failure.
7. Selector Switch - a two position station shall be provided on the enclosure marked "Automatic" and Manual".
8. Means shall be provided on the Controller to operate an alarm signal continuously while the pump is running.
9. Provisions for power supply at 220 V for diesel pump battery chargers.

10. Control equipment shall meet all requirements of NFPA20 & NFPA72.

**J. DIESEL ENGINE DRIVE:**

Diesel engine shall be UL listed or FM approved for fire protection service.
The engine shall be of the self-contained, mounted on a suitable base with the following minimum plus any others that may be necessary by NFPA-20 and local CD requirements.

1. Dual battery set sized to NFPA -20 requirements with electrolyte shipped in separate containers, rack and cables.
2. Dual battery charger of proper type for batteries used (included in UL Listed / FM Approved controller). Power to battery charger shall be supplied from electric pump control panel. Wiring from control panel to battery chargers shall be by the contractor.
3. Electric starter with suitable generator and voltage regulator.
4. Engine water pump.
5. Heat exchanger cooling system.
6. Lubricating oil pump and filter.
7. Fuel injection system.
8. Air cleaner.
9. Proper instrument panel, complete with engine run warning light, water temperature gauge, oil pressure gauge, voltmeter, totalizing type tachometer and hour meter.
10. Industrial Grade Muffler.
11. Cooling water line for the engine heat exchanger assembly.
12. Flexible exhaust connectors.

All engine wiring for automatic starting shall terminate in a proper junction box to permit connection to control panel.

**K. FUEL SYSTEM:**

A suitable fuel system for the diesel engine shall be furnished. It must be in accordance with NFPA Pamphlet No.20 and shall include above surface day storage tank, flexible hose connectors, combination vent, and fill cap.
Diesel Fuel Tank must have a UL Listed Automatic Filtration System to prevent Toxics.
UL listed Automatic Fuel Filtration and Storage Maintenance.

Fuel Storage tanks shall be kept as full at all times, but never below two third of the tank capacity.
A fuel level indicator shall be provided to activate at the two thirds tank level.
The tanks shall ensure to removal of all water and foreign material and shall be sized so that the fuel is consumed within the storage life, or provision shall be made to replace stale fuel which cleans fuel.
AUTOMATIC FUEL FILTRATION SYSTEM SHALL BE USED TO ENSURE THE QUALITY OF FUEL TO THE PRIME MOVER AND AVOID SHUTDOWN OF STANDBY SYSTEM DUE TO FUEL CONTAMINATION THE SYSTEM SHALL CONFIRM TO THE REQUIREMENTS OF NFPA 20,25, & 110 AND MUST BE UL LISTED

**A. DIESEL ENGINE DRIVE CONTROLLER:**

Automatic Microprocessor Diesel Drive Engine Control Panel: The automatic engine control panel shall be UL/FM approved for fire pump service and meet the requirements of NFPA20. The panel shall be of the floor mounted type, and enclosed in moisture and dust tight housing. A combination manual and automatic type controller with "Manual- Off-Automatic" selector shall be provided and a 240-volt single phase power failure
relay or a pressure switch, which will (when the system pressure drops) activate all electric circuits to automatically start the engine a manually stop.
Automatic starting for the diesel engine will be done by automatic cranking from battery 1, and if failed from battery 2, with certain cranking and rest period (period is programmable). Controller will try to crank engine up to six times, but if engine did not start after these six attempts, "Failed to Start Alarm" will be activated,
The engine shall be started automatically by the Controller at least once a week, adjustable, and operate a minimum of 30 minutes (adjustable). An appropriate timing arrangement shall determine the day and hour of this test.
Pressure recorder (7-day drive) shall be provided within the control panel. The controller shall incorporate the following:

1. Each charger shall be completely independent of the other charger and equipped with its own individual power transformer, rated for a maximum continuous charge current of 10A. The charger shall be of solid-state electronic design, with semi- conductor type rectifier
In case of battery failure, the charger shall initiate an alarm and provide a signal to prevent the use of the defective battery during the start attempt cycle.
2. Relays: All relays shall be equipped with manual test buttons, status "ON" – "OFF" indicators, be of the plug-in type and shall meet all voltage and current requirements.
3. Remote Alarm Circuit:

a. Engine run indicator / free contact.
b. Test running indicator / free contact.
c. Automatic mode indicator / free contact.
d. DC power healthy indicator / free contact
e. Deluge valve on alarm / indicator / free contact (programmable).
f. Remote start on alarm / indicator / free contact

4. Description of Operation: A four positions main switch shall provide selection of three starting method and one-OFF position.

I. OFF position shall shut down engine and alarms under any condition.
II. AUTO position: a water pressure switch mounted inside the controller shall provide the engine start on water pressure drop. The automatic starting circuit shall alternate the two storage batteries after each start attempt. The attempt to start cycle shall consist of six cranks and five rest periods of 15 seconds duration. In the event of one battery failure, the starting cycle shall lock itself to the remaining battery. In case of engine failure, the controller shall stop any further cranking and energize the ENGINE FAIL TO START alarm. A manual stop pushbutton shall enable engine shut down, but only after all starting causes have returned to normal. The automatic Weekly Exercise cycle shall also be operational in the auto-position. This cycle shall be programmed on the 7-day time clock. A short opening of the water solenoid valve shall create a momentary pressure drop and cause automatic engine start. A manual test switch located on the time clock shall allow for manual test operation of the weekly exercise cycle. The 7-day time clock shall hold its time on A/C power failure and not require resetting.

III. TEST Position: Engine shall start in the same manner as the above exercise cycle start. Auto Start and Manual Shut down

IV. MANUAL Position: Start pushbutton “Battery 1” or “Battery 2”, shall override all automatic starting circuits, and allow for direct manual engine start.

V. Safety Shut Down: Engine over speed condition shall shut down engine without time delay and lock out until manually reset.

The controller shall provide the following additional safety features Engine shut down in case of low oil pressure, test or optional AC failure operation only.

**B. JOCKEY PUMP:**

The Jockey pump capacity and pressure shall be as indicated in the pump schedule on the drawings.

Pump shall be constructed as follows:

Type : Vertical multi-stage motor driven, Rotation
: Counter-clockwise, viewed down Motor : TEFC
Motor bracket : Cast type, connecting motor to pump
Diffuser : Stainless Steel Impellers
: Stainless steel SN

ITEM DESCRIPTION MAKE

1 MCCB, 3 Pole, Molded Case Switch (Non-Auto), J-Frame, Part/Cat No. JDB3250WK, UL Listed, Cutler Hammer

2 MCP, 3 Pole (Motor Circuit Protector), with built in 120 VAC Shut Trip coil, Part/Cat No. HMCP250K5WS10, UL Listed Cutler Hammer

3 Rotary Handle and Shaft (J-Frame Series C Rotary Handle) 12" length, Part/Cat No. HM2R12 C u t l e r Hammer

4 Contactor, 3P 50HZ , LC1F-115Q5 -COIL 380VAC Schneider

5 Relay 24V DC Coils, 4 Core and Marked c/w Din Rail Socket GZT4-6A UL/ Listed, 14Pin R e l Pol

6 Pressure Transmitter, Range 0-25 Bar, Output 0-10V DC, UL Listed, Model: MBS-3000-060G3814

7 Automatic Battery Charger, Sentinel 300P Range, Input Supply 110/120 -220/240V AC (50/60HZ), Output 12/24V DC, UL Listed, Model: SNTL300P Compatriotic

8 Contactor 240 Volt, 50/60 Hz Coil Supply GMC, UL Listed LG

9 Isolator Switch 25A, 3 Pole with Shaft and Rotary Handle Load Break Switch, UL Listed, CSAUS/CE approved, Prog 31309, Rear Mounting MB34 Crompton Greaves

Shaft, l : Stainless steel,
Pump discharge : Flanged type
Control : Definite purpose type, magnetic starter

In NEMA II enclosure, with reset button

Pump controller shall be factory pre-wired and tested. Pressure switch shall sense low pressure in the fire pump system. Set cut-in pressure 5 PSI above main fire pump cut-in pressure. Set cut-out

pressure at system pressure. Provide minimum run timer to operate the pump for a minimum of 3 minutes.

Across the fine start, H-O-A selector switch.

Control panel to contain a disconnect switch, magnetic motor contractor and thermal overload relays with external reset Enclosure to be wall mounted with hinged door.
MAJOR COMPONENTS TO BE USED IN THE ELECTRIC, DIESEL & JOCKEY CONTROLLERS C.
PUMP TESTING
Each pump set package should be tested according to UL / FM / NFPA 20 Standards at an approved top advanced technology testing facility capable of testing all types of
UL / FM fire pumps (End Suction, Horizontal Split Case and Vertical Turbine), electric motor, diesel engines & controllers together.

Pumps testing should be done at suction pressure based on water tank level and not at suction pressure created by other systems.

Each pump set tested should be supported by a computer generated Test Report approved and signed by the Manufacturer

D. MANUFACTURER:
The Pump Manufacturer should have 20 years' experience in Fire Fighting Industry.
The Manufacturer Quality Management System accredited by recognized bodies such as UL, LPCB & BVQI
The Manufacturer should also have ISO 14001 and BS OSHAS 18001 certification for the Environment Management System and Occupational Health and Safety Management System
Fire pump manufacturer must take complete unit responsibility for the total Fire Pump package

All major components such as Fire Pumps, Diesel Engines and Controllers should be from single manufacturer.

E. WARRANTY
The Pump should have a warranty period of 5 years against any kind of manufacturing defect only.

F. SPARE PARTS
The Pump manufacturer should guarantee the availability of genuine spare parts for the pump set for a period of 10 years

**III. FIRE HYDRANTS**

**A. DRY BARREL FIRE HYDRANT**

Fire hydrants shall be manufactured either to comply with AWWA Standard C502 meeting all requirements of UL/FM or BS EN 14384 standard approved by LPCB, KItemark.

i) AWWA C502 hydrant specifications:

1. Fire hydrants shall be rated for a working pressure of 250 psi (1723 kpa) and manufactured to comply UL/FM and AWWA C502 standard.
2. Fire hydrants shall have a main valve which shall provide complete closing of the drains after 4 to 5 turns of the operating nut in the opening direction.
3. The drain ring assembly shall be replaceable without removing the hydrant from the connecting pipe or having to dig.
4. Fire hydrants shall be three-way in design, having one pumper nozzle (size as specified) and two 2-1/2" hose nozzle (side outlet). Nozzle thread type shall be as specified by the end user.
5. The operating nut shall be a one piece design, manufactured of Bronze. It shall be pentagon in shape and the nut dimensions shall be as specified by the end user
6. An arrow shall be cast on the bonnet flange to indicate the specified opening direction.
7. Hydrants shall be a "traffic-model" having upper and lower barrels joined at the ground line by a separate and breakable "swivel" flange providing 3600 rotation of upper barrel for proper nozzle facing.
8. The lower barrel shall be an integrally cast unit. The use of threaded on or mechanically attached flanges is deemed unacceptable.
9. All ferrous part shall be epoxy coated, the lower barrel shall be bitumen coated.
10. Hydrants shall be internally coated by Epoxy to avoid corrosion.
11. A bury line shall be marked on the lower barrel below the break flange to indicate proper installation depth.
12. Hydrant Inlet shall flanged and the size shall be minimum 6"

ii) BS EN 14384 hydrant specifications:
1. Fire hydrants shall be suitable for maximum working pressure of 16 bar and manufactured to comply BSEN 14384:2005 standard.
2. The design of obturator (base valve) in hydrant is made in such a way that it can be replaced at site.

3. The material of base valve shall be High Tensile Brass.
4. The drain system shall start automatically when hydrant is closed.
5. Fire hydrants shall be three-way in design, having one pumper connection 1X4" Male/Female BSRT to BS 336 and 2X2-1/2" St. thro' landing valve with female Inst. Outlet to BS 336 or 2 x 2-1/2" adaptor having female Inst. Outlet to BS 336.
6. The operating nut shall be a one-piece design, manufactured of Bronze. It shall be pentagon in shape.
7. An arrow shall be cast on the bonnet flange to indicate the specified opening direction.
8. Hydrants shall be a either Breakable or Non-breakable models.
9. All ferrous part shall be epoxy coated, the lower barrel shall be bitumen coated.
10. Hydrants shall be internally coated by Epoxy to avoid corrosion.
11. Hydrants shall be compatible against resistance to disinfection products.
12. A bury line shall be marked on the lower barrel below the break flange to indicate proper installation depth.
13. Hydrant Inlet shall flange and the size shall be either 4" or 6"

**B. WET BARREL FIRE HYDRANT**

GENERAL

Fire hydrants shall be manufactured to comply with AWWA Standard C503. Fire hydrants shall meet all requirements UL/FM. Coupling must be quick coupling as per Civil Defense requirements where coupling must be Listed & Certified.

1. Fire hydrants shall be rated for a working pressure of 250 psig
2. Hydrant Body shall be Ductile Iron.
3. All ferrous part shall be Internally & Externally Epoxy coated.

**C. UNDER GROUND HYDRANTS:**

Underground fire hydrant valves shall be of screw down type and are suitable for a maximum working pressure of 16 bar. The Inlet shall be flange type and the Outlet of this hydrant shall be round threaded 2 ½" size to BS 336 Standard.

Underground fire hydrants are manufactured to comply BS 750:2012 & EN14339:2005 and BSI KITE Mark Approved.

MATERIALS

- Body material shall be made of Grey cast iron as per BS standard
- Material of spindle shall be made of Stainless steel to BS EN 10088-1.
- Material for the screwed outlet is made of High tensile brass to BS 12163.
- Spindle sealing (two seals) is of the toroidal sealing ring ('O' ring) type.
- Design of the spindle cap in accordance with BS 5163.
- A Wiper ring is positioned above the spindle sealing to prevent the ingress of foreign matter.

DESIGN FEATURES

- The Hydrant shall be compactable against resistance to disinfection products.

RESISTANCE TO OPERATING LOADS

- Maximum operating torque value (MOT) 105 N-m
- Minimum strength torque value (MST) 210 N-m

CORROSION PROTECTION

a. All Ferrous components liable to corrosion shall be shot blasted (inside & outside) to SA 2-1/2 standard

b. Each hydrant should be painted from inside a 3 Coat epoxy paint system including primer, intermediate & Top coat

DRAINING

a. Hydrant draining system is by self-operating frost valve

b. Volume of retained water 80ml

c. Time of draining~3 min. 20 Sec.

HYDRAULIC CHARACTERISTICS

Flow co-efficient Kv equal 120 m3/hr @ 1.7 bar.

**IV. SPRINKLER SYSTEM**

A. HAZARD CLASSIFICATION:

The sprinkler system shall be designed as per NFPA-13 Installation of Sprinkler System requirements. Spacing of sprinklers shall suit the hazard of the occupancy as shown in the drawing.

B. SUBMITTAL DATA

a. Submit system layout drawings, component Shop drawings, specification and hydraulic calculations for consultant review prior to commencing installation.

b. Submit data shall be certified correct and bear the contractor engineers certification prior to submission to the consultant

c. Upon completion of installation, modify the system calculation and submit hydraulic design data base on as built system.

d. Obtain all the approvals before proceeding with the work.

C. GENERAL

All sprinklers shall be of UL listed / FM Approved

The sprinkler heads shall be of the spray pattern installed in an upright position or pendant position as may be required. Sprinkler in false ceilings shall be concealed to ceiling and to architects' approval.

The design Criteria for all sprinklers such as K-factor, type and operating temperature shall be submitted for approval.

A set of spare sprinkler heads shall be provided and located in a cabinet in the fire pump room together with sprinkler spanners for use in removing and installation of the heads as recommended in NFPA-13 and local authority requirements.

The sprinklers and lines shall not be spaced too close together in order to prevent an operating sprinkler from wetting and hereby delaying operation of adjacent sprinklers.

In locations where sprinkler heads are liable to be operated or damaged by accidental blows, stout metal guards should protect them; care being taken to ensure that the normal operation of the sprinkler head in the event of fire is not thereby impeded.

The contractor shall supply set of spare sprinkler heads in each type / temperature range and located in a cabinet in the fire pump room together with sprinkler spanners for use in removing and installation of the heads as recommended in NFPA-13 and local authority requirements.

Finish of sprinklers shall be to the approval of the architect.

D. SPRINKLER CONTROL VALVES:

1) ALARM VALVES:

It should be UL 753 listed conforming to NFPA-13. Retarding device of approved design to obviate false alarms due to mains pressure variations where necessary or where indicated.

Alarm valves shall be complete with Water Motor Alarm Gong, all required auxiliary valves and drains and with pressure switch for wiring into the building fire alarm system.

Alarm check valves shall be Ductile iron body bronze trim for minimum175 psig(12bar) working pressure complete with pressure switches, test and alarm bell connections. Pressure gauges and all other ancillaries.

2) WATER MOTOR ALARMS:

The sprinkler system shall be fitted with an approved water motor alarm, which shall be located at a distance not exceeding 21m from the alarm valve, and at a height not to exceed 6m above the alarm valve.

The pipe work and fittings used shall be galvanized and to the sizes determined by the NFPA-13

The pipe work shall be arranged to drain through a fitting having an orifice not exceeding 3 mm in diameter. The orifice plate may form an integral part of the fitting but shall be manufactured from a non-ferrous material to prevent the hole from becoming blocked by corrosion or foreign matter.

A 15 mm test valve shall be installed on the installation side of each alarm valve.

3) PRESSURE SWITCHES:

The pressure switch should be UL 753 Listed. It shall be installed in the system as per NFPA 13 and they shall be mounted on a vertical branch pipe at least 300 mm long.

The pressure switch shall be sufficiently sensitive to operate when only one sprinkler is discharging. The pressure switch shall be provided with volt free contracts to facilitate monitoring by a Building Management System, and wired to the main fire alarm panel.

4) PRESSURE GAUGES:

Pressure gauges shall be fitted to meet the requirements of the UL standards. Pressure gauges shall conform to International Standards. The maximum reading of the scale shall be 150% of the system pressure and each scale shall have divisions not exceeding 0.2 bar.

5) /ZONE CONTROL VALVE ASSEMBLY:

A zone control valve set shall UL, FM Approved and it is to be provided for each sprinkler system zone as shown in the drawings, and shall comprise:

Butterfly valve shall have UL 1091. It shall be fitted with factory installed UL/FM approved tamper switch.

Flow alarm switch shall be UL listed and FM approved for the size of the pipe in which it is installed as a paddle type water flow indicator. Shall be fixed after the butterfly valve, on the main supply pipe and before any connection is taken off.

Inspector test and drain connections.

Dial pressure gauges suitable for the water pressures shall be fitted so arranged that it can be easily removed for testing and checking without shutting down the water supply.

E. ISOLATING VALVES OS&Y TYPE:

Isolating valves shall be UL 262 Listed and shall be fitted to the installation in order to shut the valve, the spindle must turn clockwise. The hand wheels of all stop valves shall be clearly marked to indicate which direction the wheel is to be turned to close the valve.

An indication shall also be provided which shows whether the valve is open or shut.

Each main stop valves shall be installed with a tamper / supervisory switch and interconnected to the building fire alarm system or secured open by a padlock or riveted strap.

F: CHECK VALVES:

Check valve shall be UL 312 Listed and ductile iron body, swing type, flanged end with ductile iron disc, 1400 kPa (14 bar), suitable for installation in a horizontal or vertical line with flow upward. UL, FM approved.

F. DRAIN LINE

All drain lines from test valves, drain down points etc., shall discharge over suitable and proper drain vent. Each drain vent shall be connected to a 50 mm galvanized steel drain line, which shall discharge over a suitable gully.

All drain-vent, pipe fittings, and support clips used for the drain lines shall be galvanized. G. EXECUTION/ INSTALLATION.

The “Protection Area of Coverage” per sprinkler shall be determined as the multiplication of the distance between sprinklers upstream and downstream, and the perpendicular distance between a sprinkler and another on the adjacent branch line.

Installation for hydraulically calculated system with concealed pendent and upright sprinklers shall be, according to NFPA 13 latest edition and local authority requirements.

Complete Sprinkler system shall be installed in accordance with NFPA-13 and authority having jurisdiction requirements and as shown on the drawing.

The Fire protection contractor shall be responsible to co-ordinate his work with all other trades and shall be completely familiar with and shall make allowance for conditions which affect the fire protection installation.

The Zone control valve assembly locations and access panels shall be mounted securely and provided with proper sign boards.

Provide a pressure gauge with a ball valve with inspector’s test plug on top of each sprinkler pipe risers.

H. CLEANING AND TESTING

Pipes and all items of equipment shall be delivered, stored and maintained in closed storage with their open ends effectively plugged, capped or sealed. All fittings, valves and sundry items shall be stored in clean bins or bagged and stowed in suitable racks. All such stored items shall be maintained under weatherproofed cover to be supplied by the MEP sub-contractor until they are ready for incorporation in the works. Particular care shall be taken to ensure that electrical equipment and components are kept clean and dry.

Before installations are handed over or subjected to the inspection and tests, the entire installation shall be thoroughly cleaned, both internally and externally.

All fire protection installations shall be flushed out with clean water. During the flushing out, provision shall be made to exclude any items of plant, which could be damaged by the cleaning operation. The entire operation shall be carried out to the satisfaction of the Engineer.

The fire protection system shall be tested in accordance with the NFPA codes and the relevant standards, with particular reference the requirements set forth in this section:

All testing shall be performed under the work of this section. All services required for testing shall be a responsibility of the work of this section. The MEP sub-Contractor shall notify the Engineer of all tests, 48 hours prior to testing.

The fire protection piping System shall be tested hydrostatically for not less than 2 hours and at one time of the system pressure without any leaks or as directed by the local fire department.

If the systems are tested in sections, the connection to the previously tested section shall be included.

All tests that may be required by the local fire authorities shall be performed under the work of this section, in the presence of their representative, if so required.

All leaks shall be corrected and the system re-tested until no leaks are found, at no cost to the client.
Functional tests of all water flow alarms are a responsibility of the works of this Section. When the various systems are completed, operation tests shall be run on all equipment
to demonstrate proper operating conditions.
These tests shall be run under the observation of the inspector and the client's operating engineer. The client's operators shall be instructed during this period. Operation tests shall be performed under the work of this section.
Should any piece of equipment or apparatus of any material or work fail in any of these tests, it shall be immediately removed and replaced by a perfect material, and the portion of the work replaces shall again be tested under the work of this Section.
Cost to repair any damages to the building construction occasioned by pipe leaks or defective materials shall be become under the works of this section, at no cost to the client. All corrective work shall commence immediately after damage occurs.

**V. CLEAN AGENT FIRE SUPPRESSION SYSTEM**

(FM-200 / HFC-227EA)

**A. GENERAL CONDITIONS**

1. SCOPE:
This specification outlines the requirements for a "Total Flooding" Clean Agent Fire Suppression System with automatic detection and control. The work described in this specification includes all engineering, labor, materials, equipment and services necessary, and required, to complete and test the suppression system.

**2. APPLICABLE STANDARDS AND PUBLICATIONS:**
The design, equipment, installation, testing and maintenance of the Clean Agent Suppression System shall be in accordance with the applicable requirements set forth in the latest edition of the following codes and standards:
1) NFPA No. 2001 - Clean Agent Fire Extinguishing Systems
2) NFPA No. 70 - National Electrical Code
3) NFPA No. 72 - Standard for Fire Alarm System
4) Factory Mutual Approval Guide
5) U.L Listings
6) Requirements of the Authority Having Jurisdiction (AHJ)

The standards listed, as well as all other applicable codes and standards, shall be used as "minimum" design standards. Also to be considered are good engineering practices.

**3. REQUIREMENTS:**

The FM 200 Fire Suppression System installation shall be made in accordance with the drawings, specifications and applicable standards.

**4. SCOPE OF WORK**

The Specialist contract shall include the following materials / works in their scope but not limited to:

1) Design & Engineering of clean Agent fire suppression system;
2) Prepare workshop drawing and technical submittals;
3) Perform Flow calculation;
4) Clean Agent gas storage cylinders filled with gas and all hardware accessories;
5) discharge piping;
6) Discharge Nozzles;
7) Gas low pressure switch
8) Fire Detection and Alarm system c/w Optical smoke detectors, manual release, , Abort unit, First stage Alarm bell, second stage Alarm sounder, strobe horn, Gas discharge warning sign and associated cabling etc;
9) Gas release control panel
10) Interlock wiring and conduit for shutdown of HVAC, dampers and/or electric power supplies, relays or shunt trip breakers.
11) Integrity Test and Functional test;
12) Training to the client representatives
13) Provide As Built drawings and Operation & Maintenance Manuals.

The work listed below shall be provided by others, or under other sections of this specification:
1) 230VAC power supply to the Fire suppression control panel.
2) Connection to local/remote fire alarm systems, listed central alarm station.
3) Sealing of openings to maintain the protected room enclosure as Air tight.

**5. QUALITY ASSURANCE:**

**6. MANUFACTURER**

1) The manufacturer of the Suppression System hardware and detection components shall have a minimum of 10 years' experience in the design and manufacture of similar types of suppression systems and who can refer to similar installations providing satisfactory service.
2) The name of the manufacturer, part numbers and serial numbers shall appear on all major components.
3) All devices, components and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended.
4) All equipment shall be U.L listed and/or FM approved.

**7. INSTALLER:**

1) The installing contractor shall be trained by the supplier to design, install, test and maintain Suppression Systems.

2) The installing contractor shall be an experienced firm regularly engaged in the installation of automatic Clean Agent, or similar, fire suppression systems in strict accordance with all applicable standards.

3) The installing contractor must have a minimum of eight (8) years' experience in the design, installation and testing of Clean Agent, or similar, fire suppression systems.

A list of systems of a similar nature and scope shall be provided on request.

4) The installing contractor shall maintain, or have access to, a Clean Agent recharging station. The installing contractor shall provide proof of his ability to recharge the largest Clean Agent system within 24 hours after a discharge. Include the amount
of bulk agent storage available.

5) The installing contractor shall be an authorized stocking distributor of the Clean Agent system equipment so that immediate replacement parts are available from inventory.

6) The installing contractor shall show proof of emergency service available on a twenty-four hour, seven-days-a-week basis.

**8. SUBMITTALS:**

1) The installing contractor shall submit the following information for approval to the local Fire Prevention Agency, owners Insurance Underwriter, Architect/Engineer, and all other Authorities Having Jurisdiction before starting installation:

a) Field installation layout drawings scale shall be 1:100m detailing the location of all agent storage tanks, pipe runs, including pipe sizes and lengths, control panel(s), detectors, manual pull stations, abort stations, audible and visual alarms, etc.
b) Auxiliary details and information such as maintenance panels, door holders, special sealing requirements and equipment shutdowns.
c) Separate layouts, or drawings, shall be provided for each level, ( i.e.; room, underfloor, and above ceiling) and for mechanical and electrical work.
d) A separate layout or drawing shall show isometric details of agent storage containers, mounting details and proposed pipe runs and sizes.

Electrical layout drawings shall show the location of all devices and include point-to- point conduit runs and a description of the method(s) used for detector mounting.
Internal control panel wiring diagram shall include power supply requirements and field wiring termination points.

Complete flow calculations shall be provided from a U.L. listed computer program, for all engineered Clean Agent systems. Calculation sheet(s) must include the manufacturers name and U.L. listing number for verification. The individual sections of pipe and each fitting to be used, as shown on the isometrics, must be identified and included in the calculation. Total agent discharge time must be shown and detailed by zone.
Provide calculations for the battery stand-by power supply taking into consideration the power requirements of all alarms, initiating devices and auxiliary components under full load conditions.
A complete sequence of operation detailing all alarm devices, shutdown functions, remote signaling, damper operation, time delay and agent discharge for each zone or system.

**9. CLEAN AGENT SYSTEM REQUIREMENTS:**

A. SYSTEM DESCRIPTION AND OPERATION:

A) The system shall be a Total Flood Clean Agent Suppression System supplied & installed by an Authorized by the manufacturer.
B) The system shall provide minimum design concentration of 7.0%, by volume, in all areas and/or protected spaces, at the minimum anticipated temperature within the protected area. System design shall not exceed the NOAEL value of 9.0%, adjusted for maximum space temperature anticipated, unless provisions for room evacuation,
before agent release, are provided.
C) The system shall be complete in all ways. It shall include all mechanical and electrical installation, all detection and control equipment, agent storage containers, FM 200 agent, discharge nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, caution/ advisory signs, functional checkout and testing, training and all other operations necessary for a functional, U.L. Listed or F.M. approved FM 200 Clean Agent Suppression System.
D) Provide two (2) inspections during the first year of service. Inspections shall be made at 6 month intervals commencing when the system is first placed into normal service.
E) The general contractor shall be responsible for sealing and securing the protected spaces against agent loss and/or leakage during the 10 minute "hold" period.
F) The system(s) shall be actuated by cross zoned photoelectric detectors installed at a maximum spacing of 250 sq. ft. (23.2 sq. m) per detector, in both the room, underfloor and above ceiling protected spaces. If the air flow is one air change per minute, photoelectric detectors shall be installed at a spacing not to exceed 125 sq. ft. (11.6 sq. m) per detector. (Ref. NFPA No. 72 - current edition)
G) Detectors shall be wired in Sequential Detection method of operation, standard Cross-Zoned detection, Class "B" wiring arrangement. No other detection / wiring arrangements will be acceptable.
H) Automatic operation of each protected area shall be as follows:

1) Actuation of one (1) detector, within the system, shall:
a) Illuminate the "ALARM" lamp on the control panel face.
b) Energize an alarm bell and/or an optional visual indicator.

c) Transfer sets of 5 Amp rated auxiliary contacts which can perform auxiliary system functions such as:

1) Operate door holder/closures on access doors.
2) Transmit a signal to a fire alarm system.
3) Shutdown HVAC equipment.

2) Actuation of a 2nd detector, within the system, shall:
a) Illuminate the "PRE-DISCHARGE" lamp on the control panel face.
b) Energize a pre-discharge horn or horn/strobe device.
c) Shut down the HVAC system and/or close dampers.
d) Start time-delay sequence (not to exceed 60 seconds). System abort sequence is enabled at this time.

3) After completion of the time-delay sequence, the HFC-227ea Clean Agent system shall discharge and the following shall occur:

a) Illuminate a "SYSTEM FIRED" lamp on the control panel face.

b) Shutdown of all power to high-voltage equipment

c) Energize a visual indicator(s) outside the hazard in which the discharge occurred.

d) Energize a "System Fired" audible device. (Optional)

4) The system shall be capable of being actuated by manual discharge devices located at each hazard exit. Operation of a manual device shall duplicate the sequence description above except that the time delay and abort functions shall be bypassed. The manual discharge station shall be of the electrical actuation type and shall be supervised at the main control panel.

**10. MATERIALS AND EQUIPMENT:**

**A. GENERAL REQUIREMENTS:**

The Clean Agent System materials and equipment shall be standard products of the supplier's latest design and suitable to perform the functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates produced by one manufacturer.

1.) All devices and equipment shall be U/L Listed and or FM approved.

**B. CLEAN AGENT SYSTEM AND DISTRIBUTION:**

Each system shall have its own supply of clean agent.

The system design can be modular, design criteria.

Systems shall be designed in accordance with the manufacturer's guidelines.

2) Each supply container shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.

3) The clean agent shall be stored in Agent Storage Containers. Containers shall be super- with dry nitrogen, to an operating pressure of 360 psi @ $70^0$F (2482 kpa at 21°C). Container shall be of high – strength alloy steel construction and confirm to NFPA 2001.

4) Clean agent containers with an Impulse valve can be actuated by the following methods and Solenoid valve is not allowed:

Method 1: Electric actuation – Single container system with Impulse valve operator (IVO) & Impulse release Module (IRM)

Method 2: Electric actuation – Multi container system with Impulse valve operator (IVO) & Impulse release Module (IRM)

Method 3: Electric & Pneumatic actuation – Two container system with Impulse valve operator (IVO) & Impulse valve pneumatic operator (IVPO)

Method 4: Electric & Pneumatic actuation – Multi container system with Impulse valve operator (IVO) & Impulse valve pneumatic operator (IVPO)

5) Each container shall have a pressure gauge and low-pressure switch to provide visual and electrical supervision of the container pressure. The low-pressure switch shall be wired to the control panel to provide an audible and visual "Supervisory" alarm in the event the container pressure drops below 288 psi (1986 kpa). The pressure gauge shall be color coded to provide an easy, visual indication of container pressure.

6) Each container shall have a pressure relief provision that automatically operates when the internal temperature exceeds $130^0$F ($54.4^0$C)

7) Engineered discharge nozzles shall be provided, within the manufacturer's guidelines, to distribute the clean agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution.
(a) Nozzles shall be available in pipe sizes 3/8" thru 2.0" (BPS 10mm thru 50mm). Each size shall be available in $180^0$ and $360^0$ distribution patterns.

8) Distribution piping, and fittings, shall be installed in accordance with the manufacturer's requirements, NFPA 2001 and approved piping standards and guidelines. All distribution piping shall be installed by qualified individuals using good, accepted practices and quality procedures. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.
(a) All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.
(b) All pipe threads shall be sealed with Teflon tape pipe sealant applied to the male thread only.

**11. ELECTRICAL REQUIREMENTS:**

**A. CONTROL PANEL:**

Extinguishing Control Panel shall communicate with and control the equipment's to make a complete workable / operational system such as smoke detectors, manual release, abort switch, alarm devices, actuating / releasing components and other system-controlled devices.
The control panel shall include Indicating circuits, releasing circuits, alarm contacts, trouble contacts, auxiliary contacts, initiating zones, manual release circuit and abort circuit.

C. System display shall indicate the status of the following parameters of the system as follows;

| | | |
|---|---|---|
| 1 | AC POWER | Green LED |
| 2 | SYSTEM ALARM | Red LED |
| 3 | RELEASE | Red LED |
| 4 | SUPERVISORY | Yellow LED |
| 5 | SYSTEM TROUBLE | Yellow LED |
| 6 | CIRCUIT TROUBLE | Yellow LED |
| 7 | ALARM SILENCED | Yellow LED |
| 8 | POWER TROUBLE | Yellow LED |

The Control panel, and its components, shall be UL listed and FM approved for releasing service and be suitable for clean Agent release service.
The Control panel shall perform all functions necessary to operate the system detection, actuation and auxiliary functions, as outlined.
The Control panel shall be capable of providing 7AH battery standby power supplies.

The Control panel shall support Cross Zoned, Sequential, Single Detector Release and Manual Release detection/actuation methods.

**B. OPTICAL SMOKE DETECTOR:**

The detectors shall be spaced and installed in accordance with the manufacturer's specifications and the guidelines of NFPA 72 – current edition.

The optical smoke detector shall continuously measure the smoke level in the air, and gives a proportional output. It shall comply with the requirements of EN54 part 7.

The detector shall be an optical light scattering type sensitive to visible smoke and be stable under all environmental conditions. The internal test and calibration circuits shall use the same optical elements as the smoke sensing circuits, to ensure reliability. A light emitting diode (LED) on the base must illuminate when a detector is in alarm

**C. MANUAL RELEASE (ELECTRIC):**

The electric manual release switch which provides a means of manually discharging the Suppression System when used in conjunction with the Extinguishing Control panel.

Manual actuation shall bypass the time delay and abort functions, shall cause the system to discharge, and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.

A Manual Release switch shall be located at each exit from the protected hazard and shall have an advisory sign, provided at each location.

**D. ABORT STATION:**

The optional Abort Station shall be UL, FM approved and shall be located next to each manual switch. The Abort Station shall be supervised and shall indicate a trouble condition at the SHP Control Panel, if depressed, and no alarm condition exists.

"Locking" or "Keyed" abort stations shall not be permitted.

The Abort Station shall be located adjacent to each manual station.

**E. AUDIBLE AND VISUAL ALARMS:**

Alarm audible and visual signal devices shall operate from the Control Panel.

The Alarm Bell, Alarm Horn and Horn/Strobe devices shall operate on 24 volts Dc power to allow supervision of the circuit wires.

The alarm bell and horn shall deliver a minimum sound level of 100 decibels at a distance of 1m.

Horn and strobe light are to operate simultaneous from one power supply with flash rate of 1-3 flashes per second minimum over the listed input voltage range.

A Strobe device shall be placed outside, and above, each exit door from the protected space. Provide an advisory sign at each light location.

**F. CAUTION AND ADVISORY SIGNS:**

Provide signs, as required, to comply with NFPA 2001 and the recommendations of the equipment supplier:

Entrance sign: (1) required at each entrance to a protected space. Manual Discharge sign: (1) required at each manual discharge station.

Flashing Light sign: (1) required at each flashing light over each exit from a protected space.

**G. SYSTEM AND CONTROL WIRING:**

All system wiring shall be furnished and installed by the contractor.

All wiring shall be installed in conduit, and must be installed and kept separate from all other building wiring.
All system components shall be securely supported independent of the wiring. Runs of conduit and wiring shall be straight, neatly arranged, properly supported, installed parallel and perpendicular to walls and partitions.
The sizes of the conductors shall be those specified by the manufacturer. Color coded wire shall be used. All wires shall be tagged at all junction points and shall be free from shorts, earth connections (unless so noted on the system drawings), and crosses between conductors. Final terminations between the control panel and the system field wiring shall be made under the direct supervision of a factory trained representative.
All wiring shall be installed by qualified individuals, in a neat and workmanlike manner, to conform to the National Electrical Code, Article 725, and Article 760, except as otherwise permitted for limited energy circuits, as described in NFPA 72 - current edition. Wiring installation shall meet all local, state, province and/or country codes.
The complete system electrical installation, and all auxiliary components, shall be connected to earth ground in accordance with the National Electrical Code.

**H. SYSTEM INSPECTION AND CHECKOUT:**

After the system installation has been completed, the entire system shall be checked out, inspected and functionally tested by qualified, trained personnel, in accordance with the manufacturer's recommended procedures and NFPA standards.
All containers and distribution piping shall be checked for proper mounting and installation.
All electrical wiring shall be tested for proper connection, continuity and resistance to earth.
The complete system shall be functionally tested, in the presence of the owner 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.
(a) Each detector shall be tested in accordance with the manufacturer's recommended procedures, and test values recorded.
(b) 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.
(c) Each control panel circuit shall be tested for trouble by inducing a trouble condition into the system.

**I. TRAINING REQUIREMENTS:**

Prior to final acceptance, the installing contractor shall provide operational training to each shift of the owner’s personnel. Each training session shall include system Control Panel operation, manual and abort functions, trouble procedures, supervisory procedures, auxiliary functions and emergency procedures.

**J. OPERATION AND MAINTENANCE:**

Prior to final acceptance, the installing contractor shall provide complete operation and maintenance instruction manuals, four (4) copies for each system, to the owner. All aspects of system operation and maintenance shall be detailed, including piping isometrics, wiring diagrams of all circuits, a written description of the system design, sequence of operation and drawing(s) illustrating control logic and equipment used in the system. Checklists and procedures for emergency situations, troubleshooting techniques, maintenance operations and procedures shall be included in the manual.

**K. AS-BUILT DRAWINGS:**

Upon completion of each system, the installing contractor shall provide four (4) copies of system "As-Built" drawings to the owner. 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. One (1) copy of reproducible engineering drawings shall be provided reflecting all actual installation details.

**L. ACCEPTANCE TESTS:**

1. At the time "As-Built" drawings and maintenance/operations manuals are submitted, the installing contractor shall submit a "Test Plan" describing procedures to be used to test the control 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 owner 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 and manual override of abort functions. Supervision of all panel circuits, including AC power and battery power supplies, shall be tested and qualified.

3. A room pressurization test shall be conducted, in each protected space, to determine the presence of openings which would affect the agent system concentration levels. The test(s) shall be conducted using the Retro-Tec Corp. Door Fan system, or equivalent, with integrated computer program. All testing shall be in accordance with NFPA 2001.

4. If room pressurization testing indicates that openings exist which would result in leakage and/or loss of the extinguishing agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the general contractor or his sub-contractor or agent. The general contractor shall be responsible for adequately sealing all protected space(s) against agent loss or leakage. The installing contractor shall inspect all work to ascertain that the protected space(s) have been adequately and properly sealed.
THE SUPPRESSION SYSTEM INSTALLING CONTRACTOR SHALL BE RESPONSIBLE FOR THE SUCCESS OF THE ROOM PRESSURIZATION TESTS. If the first room pressurization test is not successful, in accordance with these specifications, the installing contractor shall direct the general contractor to determine, and correct, the cause of the test failure. The installing contractor shall conduct additional room pressurization tests, at no additional cost to the owner, until a successful test is obtained. Copies of successful test results shall be submitted to the owner for record.

5. Upon acceptance by the owner, the completed system(s) shall be placed into service.

**M. SYSTEM INSPECTIONS:**

The installing contractor shall 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 12-month interval, after system acceptance. Inspections shall be conducted in accordance with the manufacturer's guidelines and the recommendations of NFPA 2001.

Integrity Test must be done by qualified certified Engineer. The installer must have UL Approved filling station in U.A.E for refilling and maintenance purpose
Documents certifying satisfactory system(s) operation shall be submitted to the owner upon completion of each inspection.

**N. WARRANTY:**

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 (2) year from the date of
TOC.

**B. INERT GAS (IG541) CLEAN AGENTFIRE SUPRESSION SYSTEM**

The inert gas system suppression agent IG541 (N2, Ar & CO2 gas) shall provide a minimum design concentration of 37.5% by volume @ 21oC as per NFPA 2001, latest edition.

The system design shall not exceed the NOAEL Value of 43% adjusted for maximum space temperature anticipated, unless provisions for room evacuation, before agent release, are provided.

The system shall be designed that 95% of minimum design concentration achieved within 60Seconds.

The system shall be actuated by means smoke detectors or any special kind of detectors suitable for its application as recommended by NFPA 72. Detectors shall be installed at all room void, ceiling void and floor void of protected area. Detectors shall be wired to provide a double knock configuration. The method of operation shall be cross zone detection system.

The Automatic operation of each protected area shall be as follows:
A) Actuation of one detector (1) within the system zone shall:

- Illuminate a " ALARM" lamp on the control panel
- Energize the Fire Alarm Bell inside the protected area
- Shut down the HVAC system and associated dampers shall close
- All access door closure of protected premises.

B) Actuation of second detector (2) within the system zone shall:

- Illuminate a "PRE DISCHARGE" lamp on the control panel
- Energize the Strobe Horn
- Start Time Delay Sequence
- Enable the system abort sequence

C) After completion of the time delay sequence, the system get activated, the agent shall be discharged and the following shall occur:

- Illuminate a "SYSTEM FIRED" lamp on the control panel
- Energize the Visual indicator outside the hazard area in which the discharge occurred.

The system shall be capable of being actuated by manual discharge devices located at exit of each protected areas. Operation of manual device shall duplicate the operation of the second detector described in the above except the time delay and abort functions shall be by- passed. The manual discharge station shall be of the electrical type and shall be supervised at the control panel.

Include in addition to the above the following features in a single panel enclosure.

- Audible Circuits
- Diagnostic LED's for easy trouble –shooting
- Solid State Field programmable time delay 0to 60 seconds
- Connections to power a remote annunciation
- Agent cylinder isolating switch
- Cross – Zone Principle of agent discharge.

First Stage Alarm signal from the Inert (IG541) gas suppression system protected areas shall be interfaced & should appear in Main FACP.
All Fire Extinguishing Control Panels (FECPs)& Abort switches shall be located inside the Inert (IG541) gas suppression system protected hazard areas, wherever the exit of that particular area is directly towards the outside of the building.
All manual release units shall be located outside the hazard protected area only and shall be weather proof. When more than one exits doors are located, provide abort switches & also manual release units at all the exit areas.
For the initiating circuits (Zone 1 & 2), the End of Line (EOL) resistor shall be located inside the room void area & shall be provided in a suitable junction box on the wall at 1.4 m height from finished floor level for easy access and maintenance requirements.
All smoke detectors shall be installed at least 300mm away from any light fittings /beams as per the recommendations of NFPA 72.
Detectors inside raised floor shall be mounted on suitable GI channel supports only &
shall not be fixed directly beneath the floor tile itself.
Strobe light shall be provided in all the protected area exits.

**MATERIALS AND EQUIPMENT – GENERAL REQUIREMENTS:**

The Inert (IG541) gas suppression system materials and equipment shall be standard products of the supplier's latest design and suitable to perform the functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates produced by one manufacturer.
All devices and equipment must be UL Listed.
Warning Instructions in English & Arabic shall be provided on all exit doors of Inert (IG541) gas suppression system protected rooms.
Room Venting (Pressure relief dampers) has to be provided for each protected hazard areas.
The Supplier / Manufacturer of the IG-541 clean agent system must have approved local filling station in-house, for filling up the gas to assure the gas quality and also to ensure that the gas is filled within 24hours in case of any emergency requirements.
The Inert Gas (IG541) manufacturer / supplier shall have readily available spare parts at any time for emergency requirements.

An integrity test shall be carried out in each IG541 system protected room and test must be carried by trained & qualified engineer.

The room served by IG541 system shall be sealed and constructed to ensure it will pass a room integrity test as per NFPA 2001 requirements.

**AGENT STORAGE AND DISTRIBUTION:**

The Inert Gas (IG541) suppression system design can be modular as suitable for design criteria.
System shall be designed in accordance with the manufacturer's guidelines.
Each cylinder bank shall be located in a separate cylinder room with proper venting facilities.
The Inert Gas (IG541) fire suppression systems are designed for a cylinder filling pressure of 200 bar, 300 bar and 80 L,140L cylinder capacity in order to minimize the cylinder storage space.
Each cylinder valve shall be equipped with constant discharge pressure regulator in which the discharge outlet pressure shall not exceed 60 bar.
The cylinder bank shall contain necessary accessories like Valve actuators, discharge hose, pilot hose, check valve, manifold, safety relief disc etc.
The cylinder bank shall be actuated by means of Electric, Pneumatic or combination of both.
The cylinder bank shall be capable of manual discharge by means of mechanical and electrical actuation.
Each cylinder shall have a pressure gauge with integrated pressure switch to provide visual and electrical supervision of the cylinder pressure. The low-pressure switch shall be wired to the control panel to provide an audible and visual "Trouble" alarm in the event of cylinder pressure drops. The Pressure gauge shall be color coded to provide an easy, visual indication of cylinder pressure.
Agent cylinders shall be located in air-conditioned areas at a temperature not less than
21$^{o}$C
The Flow calculation shall be performed based on UL listed Software
Engineered discharge nozzles shall be provided, within the manufacturer's guidelines to distribute the Inert Gas (IG541) agent throughout the protected spaces. The nozzles shall be designed to provide proper agent quantity and distribution.
Nozzles shall be available in pipe sizes ½" thru 1 ½" (10 mm thru 40 mm). Each size shall
be available in 360o distribution patterns.
Ceiling plates can be used with the nozzles to conceal pipe entry holes through ceiling tiles.
Pipes and Fittings shall be as per NFPA 2001 standard recommendations. Installation of the system must be carried out by trained persons from an ISO 9001 certified company having minimum eight years' experience in installing similar type of clean agent systems.
Distribution piping and fittings shall be installed by qualified individuals using good, accepted practices and quality procedures shall install all distribution piping. All piping shall be adequately supported and anchored at all directional changes and nozzle locations.
At piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.
All pipe threads shall be seated with Teflon tape pipe sealant applied to the male thread only.
For pipes of sizes 65NB & higher, supports shall be channel type only. For smaller pipes other rigid type supports are acceptable.

All cylinder room/enclosure shall have separate door from outside and also from inside for quick access on the Inert Gas (IG541) cylinders bank during operation, maintenance & inspection of the same.

**VII. PIPES, FITTINGS AND SUPPORTS**

A. PIPES

1. Pipes and fittings shall be in conformance with the following specifications unless specified otherwise by the Authority having jurisdiction. Obtain approval of local Authorities before proceeding with the work.
2. Pipe shall be ERW UL/FM approved, as per ASTM A 53 grade B, schedule 40.
3. When pipes are assembled by screwed fitting or by roll-grooved / cut-grooved, the minimum thickness for a pressure up to 20.7 bar.
4. UL/FM listed ERW Steel pipes for sprinkler system must have factory galvanized internal and external surfaces. The threaded extremities must be oil treated to prevent corrosion and shall have a thickness of not less than 100 microns. The painted pipes shall be subject to oven baking at 200 Deg.C. The paint powder used shall be UV stabilized suitable for external weather condition and a certificate from manufacturers must be submitted. The pipes must be well wrapped so it will not be scratched during installation.
5. Diameters

- Minimum diameter is DN25

6. Pipes marking and identification

Firewater pipes in galvanized steel shall be marked to indicate its destination.

7. Pipes Drainage

For sprinkler system, pipe drainage shall be accomplished by sloping pipe to low point with auxiliary drain as per NFPA13.

8. Special Requirements

Full flanges or plugs, according to the diameter shall be installed on the collector's extremities to flushing rinsing of the pipes.

B. PIPE FITTINGS.

1. Fittings for piping 50mm and small shall be UL listed and FM approved. The fittings shall be suitable for 300 psi working pressure. Fittings shall be ductile iron in hot dipped factory galvanized finish.
2. Fittings for piping larger than 50 mm shall be red painted mechanical grooved fittings and mechanical joints. Fittings, gaskets and mechanical couplings shall be UL listed and FM approved. The fittings shall be suitable for 300 psi working pressure
3. Pipes welding shall not be carried out on site.
4. The ductile iron fittings shall be Ul Listed and or FM approved.
5. Unions and Couplings

Screwed unions shall not be used for pipe grater than DN40. For pipes above, flanges will be used.

6. Reducers and male/female reducers

- One-piece reduced fitting must be used for each pipe diameter change.
- Reduced sleeve for the pipe continuity, and
- Male/female reducer for a direction change with reduction (T shape + reducer)

PIPE HANGERS & SUPPORTS:

1. Pipe hangers and supports must be in accordance to NFPA13.
2. Pipes supports shall be designed to maintain their integrity in case of fire exposure.

3. All underground piping / valves shall be supported with Concrete Anchor Thrust blocks as recommended by the manufacturer. Provide calculation for the Engineers approval.
4. All Above ground piping / equipment's hangers, supports shall be fabricated in accordance with MSS SP-69 & SP-58. The Hangers, rod supports and supporting devices and accessories shall be capable of supporting at least twice the live loads of the product being supported. All hangers, supports and accessories shall be UL listed and FM approved.
5. Hangers shall be UL,FM approved swivel ring type.
6. Riser clamps shall be galvanized steel bands shaped to tightly fit O.D. of the pipe, secured with bolts and nuts.
7. Piercing of load supporting system is not permitted.
8. The supporting structure can be directly attached to equipment's if the equipment supplier certifies this supporting feasibility.
9. The welding of pipes on the supports on the pipes is not permitted.
10. Pipes supporting system must be reinforced in order to reduce any movements resulting from nozzles reaction and therefore preserve the system performance and integrity if battering ram is used.
11. The maximum length for a non-supported DN 25 pipe is 0.8 meter.
12. If spring hangers are used, they shall be installed and located in accordance with NFPA 13 specifications.
13. The Contractor shall consider the problem of dilatation (of his systems but also of the buildings) and shall make the coordination with the others Contractors to solve the support problems.

**VIII. HDPE PIPE**

1. SCOPE:

This specification sets the minimum acceptable requirements for the supply of HDPE pipes and fittings.
HDPE pipes and Fittings must be manufactured to ISO 4427 standards. All Pipes and Fittings must be listed by FM to be installed in underground fire main, the pipes and fittings to be SDR9 PN20 Pipes & fittings. Pipes and fittings must be from same raw materials and same manufacturer to ensure the homgonesity of welding.
The manufacturer should have a certified ISO 9001:2015 QMS and ISO 14001:2004

2. APPLICABLE STANDARDS AND CODES
High Density Polyethylene (HDPE) pipes and fittings should be manufactured in compliance to the latest issue of the following standards:
AWWA C906 Polyethylene (PE) pressure pipe and fittings, 2 ½ In. (63 mm) Through 24 In.(630mm) for water Distribution & Transmission

3. APPLICATIONS
3.A - firefighting - underground pipes & fittings (up to 13.7 bar) FM approved

1. High density Polyethylene Pipes and fittings (HDPE) PE100 Manufactured for underground fire Protection lines, FM approved SDR9 PN20 Pipes & fittings confirm to ISO 4427 standards and comply (or) designed to NFPA 24.
2. Pipes and fittings to be from one manufacturer to meet above standards.

3. Welding to be butt fusion only, suitable for pipe pressure ratings and each joint should have separate report showing full details on joint and welding process and result

4. Selection:
Pipes & fittings selection should take into consideration the working pressure and Shut off pressure of the pump with pressure reduction factor to the temperature.

5. HDPE. MATERIAL CHARACTERISTICS
Pipes are made of PE100; processed according to the quality specifications & dimensions according to applicable standards; Temperature application range -40°C to
60°C; colour - black.
HDPE pipes and fittings should be suitable for butt fusion welding techniques.
5.1) Physical and mechanical characteristics
To use HDPE Raw material which is approved by PE100+ Association.

The compound used in the process shall comply with the specifications in ISO 4427 standards & ASTM D3350.
Pipes should be produced with 100% Black virgin material. Compound comes directly from a resin supplier. Using resin + master batch mixed during extrusion is not allowed.
The material of the polyethylene pipes and fittings which is in contact with drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water.

5.2) Testing of finished product
Once manufactured, the finished pipe, after conditioning, shall pass the following criteria:

Hydrostatic Pressure Test:
As per FM Approved requirements, a pressure test at 3times the pressure class at 23 Deg.C for 5 Seconds should also carry out.

* The internal Pressure of the pipe shall be calculated according to the geometry of the pipe (External diameter and wall thickness)

6) DIMENSIONS
The dimensions of the Pipes & segmented butt fusion fittings shall be as per the latest version of the manufacturer drawings and to be compatible with pipe OD
& wall thickness at the joint.

7) INSPECTION AND TESTING
7.1) Test results and frequencies
The Manufacturer of pipes & fittings shall maintain a complete record of test results according to the requirements of the applicable standards ISO 4427 standards and this specification & should perform the following tests:
For pipes:
Dimensions (Outer Diameter & Wall Thickness) as specified in the applicable standards.
Tensile test – Elongation at Break
Resistance to internal Pressure Hydrostatic test. Density & MFR
Bend back test

For fittings:
Dimensions as specified in applicable standards. Tensile strength & Hydrostatic pressure test When required, shall supply copies of all Test certificates for its products conforming to applicable standards ISO 4427 standards

7.2) Inspection Requirements
Pipes shall comply with ISO 4427 standards
In case of bulk supplies or bulk procurements (including major Projects), to verify the compliance with this Specifications, factory inspection by an independent third-party auditor at the cost of the Client / Contractor. The third-party auditor shall be of International reputed and the one opted by client. The auditing and quality testing procedures would be as per the prevailing internationally accepted codes of testing as indicated in the document.
Manufacturer shall provide full assistance and co-operation for any such inspection, when required by Client.
Manufacturer shall ensure that all the applicable codes and standards are available at their works for Client's reference during their visit to manufacturer's works for inspection/tests.

7.3) Acceptance criteria

Following requirements are a must for the approval/acceptance of the finished product:
A copy of the raw material manufacturer’s certificate of quality control testing covering each batch of raw material used for pipes purchased under this specification,
Pipe wall thickness shall be controlled by continuous scanning using Ultra sonic Scanning gamma ray .
Successful test performance and acceptable results mentioned in this specification,
An acceptable inspection report from a third-party inspection above mentioned. (if applicable)
When a pipe / fitting is rejected, the items manufactured immediately before or after shall be carefully examined. If further defects are found, the entire batch will be rejected.

8) QUALITY ASSURANCE AND QUALITY CONTROL
The Manufacturer should ensure that all testing is done as per the Applicable standards and test method referred.
All test results are recorded. A copy of TEST CERTIFICATE as a compliance of Quality Assurance and Quality Control shall be submitted with each batch for review and approval.

9) MARKING
All marking complies with ISO 4427 standards. All the marking is repeated at least every 1.0 m and displayed on the outside of the pipe length with the following information.
Standard number, Manufacturer/Trademark, Nominal pipe outside diameter (OD) Standard Dimensional Ratio (SDR) value, Material Designation, Pressure rating in bar (i.e. Pressure Rating), Material manufacturer’s identification (includes plant code, machine, date, month, year, Shift, Material Code & time.)

10) PACKING, STORING AND DELIVERY

The Manufacturer shall provide packing and shipping procedures for approval and shall comply with the following requirements:

10.1 Delivery

Delivery of pipes and fittings shall be not later than 6 months after the manufacture date.

10.2 End caps

The ends of the Straight pipes and coils have Polyethylene wrapping at both ends that prevent dirt and debris from entering the pipe during handling storage and transport

10.3 Pallets

The pallets shall be suitable for transporting the pipes and fittings from the plant to the designated location without causing any damage. The pallets shall not contain any broken planks or extremities that may damage the pipe.

10.4 Trucking

Where pipes are transported by vehicles, the vehicles should have a flat bed and be free from sharp edges or projections.

10.5 Storage

Straight lengths should be stacked firm, flat ground to support the weight of the pipes and any lifting equipment and without being allowed to bend in any direction.

Coils should be stored horizontally just as they are normally delivered. Coils shall not be stacked higher than 2.5 m.

11) DOCUMENTATION

Manufacturer shall furnish the following vendor data as a minimum:

- Catalogues of the proposed product,
- Dimensional details of pipes and fittings,
- Complete details of testing facilities,
- Detailed material specification,
- Manufacturer’s drawings, showing fittings dimension
- Quality assurance procedures in use.

12) UNIFORMITY

Pipes, fittings and other accessories shall be supplied from one manufacturer to ensure correct and proper jointing between components and uniform chemical and physical properties of the piping system.

13) Training, Certification and Installation

Site personnel, involved with PE 100 piping installation, shall undergo training and Certification from an authorized representative prior to performing any jointing Operations on site. Installation shall be in accordance with the manufacturer recommendations.

# SECTION 08
# SMOKE MANAGEMENT SYSTEM

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**GENERAL**

A) SMOKE EXTRACT & PRESSURIZATION FANS

B) DAMPERS

C) SMOKE VENTS

D) CURTAINS

E) FIRE RATED DUCT

F) FIREFIGHTERS SMOKE CONTROL PANEL

## A. SMOKE EXTRACT & PRESSURIZATION FANS

a. Smoke extract fans and dual-purpose smoke extract fans shall comply with the requirements BS EN 12101-3.

b. Fan should be BSI Kitemark certified.

c. Fans should be approved by Local Civil Defense.

d. Fans shall be selected to deliver the required air volume flow rate and meet the noise levels indicated. Any allowances required to meet manufacturing tolerances shall be included.

e. The installer shall ensure that the fan is capable of generating sufficient pressure to meet the required volume flow in the ductwork system as installed including any effect on fan performance from suction and discharge connections.

f. Fan resistances shall take account of pressure drop across filters in dirty conditions (if applicable).

g. Impeller with high efficiency airfoil blades in plastic material or in die-cast aluminum alloy. Hub in die-cast aluminum alloy. Balancing according to UNI ISO 1940 norm. Variable pitch angle in still position.

h. Impeller should be directly coupled with Motor Shaft. i.e. Casing should be steel sheet with epoxy Coating.

j. Fan impellers shall be statically and dynamically balanced at the works of the manufacturer and test certificates issued to the Engineer.

k. Fans shall be constructed to proven design standards and shall be capable of withstanding the pressures and stresses developed during continuous operation at the selected duty, during starting, during stopping and during speed and duty changes. Fan casings shall be of substantial construction, adequately stiffened and braced to prevent vibration and drumming. Bolted inspection covers shall be provided to allow easy access to internal working parts.

l. Fan should have anti vibration isolators to avoid any vibrations.

m. Fans and drives shall be mounted on rigid base-frames or support structures to ensure that proper alignment is maintained.

### 1. Axial Smoke Extract & Pressurization Fans

a. Smoke extract fans and dual-purpose smoke extract fans shall comply with the requirements BS EN 12101-3. Where fans are arranged in a run and standby they shall also be accredited to BS EN 12101-3.

b. Fans and ancillaries shall be constructed to withstand the rated temperatures for the required duration as indicated and shall be suitably accredited to BS EN 12101-3. Motors and drives shall be similarly constructed or protected and ventilated to ensure that they are not subjected to fire conditions.

c. Units shall be suitable for normal operation in ambient conditions up to 50°C and high temperature conditions up to 400°C for 2 hours.

e. Impeller with High efficiency airfoil blades, variable pitch angle in still position, in cast aluminum. Balancing according to UNI ISO 1940 norm.

f. Axial flow fans shall be of the long casing pattern with a heavy gauge, steel sheet casing flanged and drilled at each end. Casings shall be epoxy Coated and fully air tight.

g. Motors shall be pre-wired with high temperature rated cable to an external terminal box through high temperature flexible conduits. All components shall be rated for the operating conditions.

h. Fans shall incorporate inlet and outlet flanges with pre-drilled bolt holes, and an external terminal box to IP55. The motor shall be foot mounted and protected to IP55 (shall be either 4, 6 or 8 poles), class H insulated and shall have sealed for life bearings.

i. Axial fan motors shall have non-overloading characteristics within the normal working range.

j. Fans shall be suitable for either vertical or horizontal mounting. They shall be mounted on purpose made supports incorporating anti-vibration mountings and mounting feet.

k. Air-tight inspection doors shall be provided giving access to fan impeller and motor and other components requiring regular servicing or maintenance.

l. Rotors shall be statically and dynamically balanced.

m. Motors in the air stream shall be totally enclosed air over or totally enclosed fan cooled squirrel cage induction

n. Control Panel for the Smoke Extract Fans shall be UL Listed. It shall be interfaced with the Fire Alarm Panel.

**2. Roof Mounted Smoke Extract Fans**

a. Smoke extract fans and dual-purpose smoke extract fans shall comply with the requirements BS EN 12101-3.

b. Roof extracts units shall be curb mounted axial type with vertical discharge impeller.

c. Fan should be with Galvanized Aluminium Cover for weather protection.

d. Back-draught dampers and/or fire release dampers shall be provided where indicated.

e. Balancing should be according to UNI ISO 1940.

f. Impellers shall be high efficiency airfoil blades. Hub in die cast aluminum & variable pitch angle in still position.

g. Protection grid should be according to UNI 9219.

h. Control Panel for the Smoke Extract Fans shall be UL Listed. It shall be interfaced with the Fire Alarm Panel.

**3. Motors and Drives**

a. Motor manufacturer should be ISO 9001: 2008 certified. b. Motors should be complying with IEC 60034 standard.
c. Motors for 400 C should have CE mark, EN12101-3/2001 compliance & LGAI certified.

d. Efficiency of motor should comply with IEC 60034-2-1: 2007.

**B. DAMPERS**

**1. MOTORIZED COMBINATION FIRE & SMOKE DAMPER (MFSD)**

a. Motorized Combination Fire & Smoke Damper can be used as a Motorized Smoke Damper for Smoke Applications.

b. They are only required on fresh air make up and smoke extract systems.

c. The Dampers along with the Actuator shall be UL listed for the intended service. Listing shall comply to UL 555S & UL 555.
d. Above Motorized Fire & Smoke Dampers shall have 3 Hours Fire Rating and Class I, II, III Leakage.

e. Frame shall be made of 16G (1.5 mm) thick Galvanized Iron Sheet.

f. Blades shall be made of 16G (1.5 mm) thick Galvanized Iron Sheet, Single Skin for parallel operation.

g. MFSD shall have a Thermal Resetting Device suitable for 72°C (165°F) as standard, which shall send Open/Close signal to Damper as per requirement.

h. Mounting sleeve shall be of length 400 mm.

i. Motorized Combination Fire & Smoke Dampers product shall be approved by Local Civil Defense.

j. Control Panel shall be interfaced with the Fire Alarm Panel.

**2. MOTORIZED SMOKE DAMPERS (MSD)**

a. Motorized smoke dampers are only required on fresh air make up and smoke extract systems.

b. Motorized Smoke Dampers shall be of UL 555S rated, for leakage Class I, II, III for temp 250°F (& 350°F)

c. Frame shall be made of 16G (1.5 mm) thick Galvanized Iron Sheet, as per ASTM 653 A.

d. Blades shall be made of 16G (1.5 mm) thick Galvanized Iron Sheet, as per ASTM 653 A.

e. Bearings shall be made of Bronze oil impregnated.

f. Sleeve shall be made of 18G GI sheet. Sleeve width shall be 200 - 400 mm, as per SMACNA standard.

g. Motorized Smoke Damper shall be operated using a Spring Return Actuator 230/24 VAC of suitable Torque.

h. Motorized Smoke Dampers product shall have a UL label and shall be approved by Local Civil Defense.

i. Control Panel shall be interfaced with the Fire Alarm Panel.

**3. FIRE DAMPERS – CURTAIN TYPE**

a. Fire Dampers shall be UL classified for 1 ½ Hours or 3 Hours Fire Rating as per UL555.

b. Frame shall be made of 18G (1.2 mm) thick Galvanized Iron Sheet.

c. Blades shall be made of 0.8mm thick GI Roll formed and interlock type.

d. Fusible link shall be UL Listed, Bi metallic, with temperature rating 72°C (165°F) as standards. Higher temperature ratings are optional.

e. Constant force coil springs for closing and latching of interlock blades.

f. Damper shall contain a Spring Holding Bracket (Ramp) to facilitate latching of blades.

g. Fire Dampers shall be approved by Local Civil Defense.

h. Fire Dampers shall NOT be used in Smoke Extraction Ducts.

**C. SMOKE VENTS**

**1. SMOKE VENTS – FLAP OR LEAF TYPE**

a. The Ventilator shall be suitable for Smoke Ventilation.

b. The Flap Type Natural Smoke Ventilator shall be tested to EN 12101-2:2003 and shall be CE marked.

c. Smoke Vents shall be approved by Local Civil Defense.

d. Smoke Vents shall be of Single Flap or Double Flap Type as per the size/dimensions required.

e. Base shall be made of Aluminium.

f. Flap/ Leaf shall be of Aluminium Sandwich Panel insulated with min. 20 mm thick extruded polystyrene.

g. For other specific project requirements, Flap/Leaf type shall be of Glazing with Polycarbonate material.

h. The Smoke Vents shall be operated electrically with the help of single/ multiple Actuators as per vent dimensions.

i. Control Panel for the Smoke Vents shall be UL Listed. It shall be interfaced with the Fire Alarm Panel.

**2. SMOKE VENTS – LOUVERED TYPE**

a. The Ventilator shall be suitable for Normal Make up Air Inlet and for Smoke Ventilation as per application requirements.

b. The Louvered Type Natural Ventilator shall be tested to EN 12101-2:2003 and shall be CE marked.

c. Smoke Vents shall be approved by Local Civil Defense.

d. The basic components of louvered vents shall contain base, flange, blades and actuator. Wind deflectors shall be added to the louvered smoke vents construction if mounted in Roof.

e. The base of the louvered vent shall be made up of 2 mm thick Aluminium sheet. Between the Base and the Blades there shall be an EPDM sealing to ensure complete water tightness of the louvered vent.

f. Blades Filling shall be made of formed Aluminium sheet profiles insulated with min. 20 mm thick extruded polystyrene.

g. For other specific project requirements, Blades shall be 16 mm thick cellular polycarbonate.

h. The Smoke Vents shall be operated electrically with the help of single/ multiple Actuators as per vent dimensions.

i. Control Panel for the Smoke Vents shall be UL Listed. It shall be interfaced with the Fire Alarm Panel.

**D. CURTAINS**

**1. SMOKE CURTAINS**

a. Fixed Smoke Curtains or Automatic Smoke Curtains shall be used to isolate an area and keep the smoke from spreading from one area to another, as per project requirements. Smoke Curtains shall be used to guide the smoke towards the extraction system available within the building.

b. Smoke Curtains fabric shall withstand a fire resistance temperature of 600°C for 2 Hours of exposure to fire.

c. Acceptable Manufacturer: NAFFCO, UAE (SI KA TEC, GERMANY)

d. Smoke Curtain Fabric Material shall be made to either of the following types:

- High quality woven glass fabric (430g/ m²) or panama weave fabric coated with 40g silicone each side, it shall have a thickness of 0.4mm and total weight of 510g m²

- High quality woven glass fabric (430g/ m²) coated with 20g polyurethane each side, it shall have a thickness of 0.4mm and total weight of 470g/ m². -

**2. FIRE CURTAINS**

a. Fire Curtains shall be used in a building to create a fire-resistant barrier whish shall protect a section of the building from Fire or Smoke damage.

b. Fire Curtain fabric shall withstand a fire resistance temperature of 1100°C for 2 Hours of exposure to fire.

c. Acceptable Manufacturer: NAFFCO, UAE (SI KA TEC, GERMANY) Fire Curtain Fabric Material shall be made of:

d. High quality 67% woven E-glass and 33% stainless steel wire fabric (630g/m²) or Panama weave fabric coated on one side or both sides with 25g of Polyurethane, it shall have an approximate thickness of 0.7mm and a total weight of 680g/m².

Fabric for Smoke and Fire Curtain meet the following standards when tested as a full system

- EN 12101 - 1: 2005 + A1:2006 Smoke and heat control systems specifications for smoke barriers

- EN 1634 – 1: 2008 – Monitoring of air temperature

- EN 1634 – 3: 2004 + AC:2006 – Fire Resistance, Smoke Control tests

- EN 1364 – 1: 1999 – Fire Resistance tests for non-load bearing elements Walls

- EN 13501-4 + A1-2010 Fire Classification of construction and Building elements

- EN 13501-1:2007 +A1 2009 – Building - Reaction to fire classification (BS 476 Class 0)

- BS 476 Class 0

Panel for the Automatic Smoke & Fire Curtains shall be interfaced with the Fire Alarm Panel.

**E. FIRE RATED DUCT**

a. Fire Rated Duct shall be used for applications such as Car Park Ventilation, Smoke Extraction, Kitchen Extraction and Pressurization Systems.

b. The Fire Rated ductwork shall be rated for both Type A (Fire Outside) and Type B (Fire Inside and Outside) fires in accordance with BS 476; Part 24:1987 (ISO 6944: 1985), designed in accordance to BS 5588: Part 9:1989, Method 3.

c. The Duct work system shall meet the requirements for stability, integrity and insulation to the service provided e.g. Smoke Extract, Kitchen Extract as per BS 476 part 24.

e. Under normal non-fire operating conditions, the ductwork should conform to the Class C pressure/leakage classification of the current HVCA DW/144 specification for sheet.

f. All Hanging and support accessories required for installation of the Duct work shall be in line with BS 476: Part 24.

g. Sealants, Gaskets and Flanges shall be provided by the Fire Rated Duct Manufacturer.

h. The complete Fire Rated Duct system shall be rated for 2 Hours as per Local Civil Defense Requirements.

i. Upon completion of installation a certificate of conformity shall be issued by the Supplier /Manufacturer to confirm that the system has been manufactured and installed correctly.

j. Fire Rated Duct product shall be approved by Local Civil Defense.

**F. FIREFIGHTERS SMOKE CONTROL PANEL**

The Firefighters Smoke Control Panel shall perform all functions necessary to operate the system actuation and auxiliary functions, as outlined.

INDICATIONS: -

A building diagram that clearly indicates the type and location of all smoke control equipment, fans, dampers etc. as well as areas served by the equipment shall be part of the Smoke Control panel.

Status of individual smoke control equipment shall be provided.

A means of positive feedback or (proof) of operation for all fans and damper position. Fault Status and Audible Alarm should be ACTIVATED if fan and damper maximum

response time is exceeded. Maximum response time for fans is generally 60 seconds, 75 seconds for Dampers. Audible alarms to Resound after 24 Hours if Fault Condition is not Cleared.

Panel Power ON LED

Graphic representation of smoke control system

Current Status for each Smoke Control System Equipment = On, Off, Open, Close, Modulating.

Pushbutton for Lamp Test

Fault LEDs for failure of each Smoke Control System Equipment.

The LEDs shall have an operating life of a minimum of 170,000 hours of continuous or pulsed operation

Audible alarm for Fault condition

Key Switch of Alarm Silence

Fans within the building shall be shown on the Smoke control panel. A clear indication of the direction of airflow and the relationship of components shall be displayed. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone, and by pilot-lamp-type indicators as follows:

Fans, dampers and other operating equipment in their normal status > WHITE. Fans, dampers and other operating equipment in their off or closed status > RED. Fans, dampers and other operating equipment in the on or open status > GREEN. Fans, dampers and other operating equipment in a fault status > YELLOW/AMBER.

Manual override for all equipment.

CONTROL: -

Panel should have manual override for complete smoke control system for fire fighters.

Panel shall provide control of individual Smoke Control equipment in smoke control system as per design.

Rotary switches shall be used for specific panel operations unless other switch types are specified. A key switch shall be used for panel enable operation when specified. Switches shall be rated for the load served.

A momentary pushbutton shall be provided for simultaneous testing of all LEDS.

ON-AUTO-OFF fan control and OPEN-AUTO-CLOSE damper control should be provided with three position rotary switches.

Four position switches should be provided for dampers if PURGE-AUTO-PRESSURIZE-OFF

**END OF SECTION**

**SECTION 08**
**LPG SYSTEM**

**LIQUEFIED PETROLEUM GAS INSTALLATION INDEX**

1. SCOPE OF WORKS
2. CONTAINER DESIGNER OR SERVICE PRESSURE
3. CONTAINER APPURTENANCES
4. PIPING, FITTINGS AND VALVES
5. INSTALLATION OF PIPE, TUBING, PIPE AND TUBING FITTINGS, VALVES AND HOSE
6. LPG VAPORIZERS
7. GAS LEAK DETECTION SYSTEM
8. PERSONNEL
9. PAINTING AND IDENTIFICATION
10. TESTING AND COMMISSIONING

## 1.0 SCOPE OF WORKS.

1.1. The work shall include design check, supply, and installation, testing, commissioning adjustment and setting to work of the LPG installation.

1.2 By virtue of carrying out a check on the complete design, the contractor is to assume full responsibility for the correct functioning of the system and to carry any liability or other insurance or guarantee as may be necessary to protect all parties in this regard

1.3 The subcontractor shall be responsible for coordination with other trades and services and shall provide all materials, labor and supervision, equipment, tools, appliances, services, etc. for carrying out the following items of work:

- LPG Storage tanks with all supports, valves and accessories as per NFPA 58.
- LPG distribution pipework with all valves, supports, controls, etc.
- LPG regulation and metering devices.
- LPG detection and alarm system.
- Fire protection installation for LPG tanks like deluge system for above ground tanks and cathodic protection for underground tanks.
- Protective painting of all materials installed within this section of the contract.
- Identification of all services.
- Electrical power and control panels for power supply to equipment including cabling from panels to respective equipment.
- All builder's work including breaking and making good of walls, floors, etc., equipment foundation pads, sleeves, etc.
- Hoisting of heavy equipment.

1.4 All installation shall be carried out by contractor approved by the Local Civil Defense Authority for this work.

1.5 All equipment and materials supplied shall comply with the requirements of the Local Civil Defense Authority.

1.6 Contractor to check for the network distributed gas network pipes at the site and coordinate with the authority. Provision for both network and tank type to be provided.

1.7 Installation shall comply with the requirements of:

- The local Civil Defense Authority
- NFPA 58
- British Standards Code of practice LPG 1TA.

## 2.2 Container Design or Service Pressure

2.2.1 The minimum design, or service, pressure of DOT specification containers shall be in accordance with the appropriate DOT regulations.

2.2.2 The minimum design pressure for ASME containers shall be in accordance with Table 2.2.2.

2.2.3 Containers shall be designed to be self-supporting without the use of guy wires and shall satisfy proper design criteria considering wind, seismic (earth-quake) forces, and hydrostatic test loads.

2.2.4 Design pressure (see Table 2.2.2) shall be interpreted as the pressure at the top head with allowance made for increased pressure on lower shell sections and bottom head due to the static pressure of the product.

Table 2.2.2

| For Gases with Vapor Pressure in psig (MPa gauge) at 100 deg.F Not to Exceed | Minimum Design Pressure in psig (MPa gauge) ASME Code Section VIII, Division 1, (37.8 deg.C) 1980 Edition (Note 1) |
|---|---|
| 80 (0.6) | 100 |
| 100 (0.7) | 125 |
| 125 (0.9) | 156 |
| 150 (1.0) | 187 |
| 175 (1.2) | 219 |
| 215 (1.5) | 250 |
| 215 (1.5) | 312.5 (2.2) |

2.2.5 Wind loading on containers shall be based on wind pressures on the projected area at various height zones above ground in accordance with Design Loads for Buildings and other structures, ANSI A58.1. Wind speeds shall be based on a Mean Occurrence Interval of 100 years.

**2.3 Container Openings**

2.3.1 Containers shall be equipped with openings suitable for the service in which the container is to be used. Such openings may be either in the container proper or in the manhole cover, or part in one and part in the other.

2.3.2 Connections for pressure relief valves shall be located and installed in such a way as to have direct communication with the vapor space, whether the container is in storage or in use. If located in a well inside the container with piping to the vapor space, the design of the well and piping shall permit sufficient pressure relief valve relieving capacity. If located in a protecting enclosure, design shall be such as to permit this enclosure to be protected against corrosion and to permit inspection.

2.3.3 Containers shall be fabricated so that they can be equipped with a fixed liquid level gauge(s) capable of indicating the maximum permitted filling level(s).

**2.4 Container Markings**

2.4.1 Containers shall be marked as provided in the Regulations, Rules or Code under which they are fabricated and in accordance with 2.4.2 and 2.4.3.

2.4.2 When LP Gas and one or more other compressed gases are to be stored or used in the same area, the containers shall be marked "Flammable" and either "LP-Gas," "Propane" or "Butane." Compliance with marking requirements of title 49 of the Code of Federal Regulations shall meet this provision.

2.4.3 ASME containers shall be marked as noted hereunder. The markings specified shall be on a metal nameplate attached to the container, so located as to remain visible after the container is installed. The nameplate shall be attached in such a way that corrosion of the nameplate or the container will be minimized.

a) Service for which the container is designed; i.e. underground, above ground, or both.

b) Name and address of container supplier or trade name of container. c) Water capacity of container in lb. or U.S. Gallons or imperial gallons. d) Design pressure in psig.

e) The wording "This container shall not contain a product having a vapor pressure in excess of- psig at 100 deg. F".
f) Tare weight of container fitted for service for containers to be filled by weight.
g) Outside surface area in sq. ft.
h) Year of manufacture.
i) Shell thickness Head thickness
j) OL - OD - HD
k) Manufacturer's Serial Number.
l) ASME Code Symbol.

## 3.0 CONTAINER APPURTENANCES

3.1 General

3.1.1 This section includes fabrication and performance provisions for container appurtenances, such as pressure relief devices, container shut off valves, backflow check valves, plugs, liquid level gauges, fixed level gauge and pressure gauges connected directly into the container openings.

3.1.2 Container appurtenances shall be fabricated of materials suitable for LP-Gas service and resistant to the action of LP-Gas under service conditions the following shall also apply:

a) Pressure containing metal parts of appurtenances, shall have a minimum melting point of 1500 deg. F (816 deg.C) such as steel, ductile (nodular) iron, malleable iron or brass. Ductile iron shall meet the requirements of ASTM A 395 or equivalent and malleable iron the requirements of ASTM A 47 or equivalent.
b) Cast iron shall not be used for parts such as bonnets or bodies.

3.1.3 Container appurtenances shall have a rated working pressure of at least 250 psig (1.7 MPa gauge).

3.1.4 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP Gas.

They shall be made of metal or other suitable material confined in metal having a melting point over 1500 deg. F (816 deg.C) or shall be protected against fire exposure, except that aluminium O-rings and spiral wound metal gaskets are acceptable. When a flange is opened, the gasket shall be replaced.

3.1.5 The tank shall be equipped with at least:

a) A continuous liquid level monitor with remote indicator.
b) A fixed maximum level gauge e.g. of the vent-valve type, with 1.5 mm or less orifice diameter.
c) A shut-off device for each connection of the outlet pipes for both gaseous and liquid phases and in addition an excess flow valve for the liquid phase.
d) A safety relief valve, it may be of the internal or external type. The minimum rate of discharge shall be calculated to the formula:
Discharge rate = 10.6552 S0.82m3/Min air at 1 atm. S = Total exterior surface in m2.

3.2 Pressure Relief Device

3.2.1 Containers shall be equipped with one or more pressure relief devices which shall be designed to relieve vapor.
3.2.2 DOT containers shall be equipped with pressure relief valves or fusible plug devices as required by DOT Regulations.
3.2.3 ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with applicable requirements of the Standard on Safety Relief Valves for Anhydrous Ammonia and LP Gas, UL 132; Standards for Safety Relief Valves of the Factory Mutual Research Corporation; or other equivalent pressure relief valve standards. The start to leak setting of such pressure relief valves, with relation to the design pressure of the container shall be in accordance with Table 3.2.3.

**Table 3.2.3.**

| Containers | Minimum | Maximum |
|---|---|---|
| All ASME Codes prior to1949 Edition and the 1949Edition paragraphs U-68 and U-69. | 110% | 125% |
| ASME Code, 1949 Edition Paragraphs U-200 and U-201 and all ASME Codes later than 1949 | 100% | 100% |

Manufacturers of pressure relief valves are allowed a plus tolerance not exceeding 10 percent of the set pressure marked on the valve.

3.2.4 Pressure relief valves for ASME containers shall also comply with the following:

a) Pressure relief valves shall be of sufficient individual or aggregate capacity as to provide the relieving capacity for the container on which they are installed and to relieve at not less than the rate indicated before the pressure is in excess of 120 percent of the maximum (not including the 10 percent referred to in the footnote of Table 5.3.2.3) permitted start-to-leak pressure setting of the device.

b) Each pressure relief valve shall be plainly and permanently marked with:

1) The pressure in psig at which the valve is set to start-to-leak;
2) Rated relieving capacity in cu ft. per minute of air at 60 deg. F (15.6 deg. C) and 14.7 psia (0.1 MPa absolute); and (3) the manufacturer's name and catalogue number. Example: A pressure relief valve is marked 250-4050 AIR. This indicates that the valve is set to start to leak at 250 psig (1.7 MPa gauge); and that its rated relieving capacity is 4050 cfm (1.9m3/s) of air.

c) Shut off valves shall not be located between a pressure relief device and the container, unless the arrangement is such that the relief device relieving

capacity flow specified in 5.3.2.4 (a) will be achieved through additional pressure relief devices which remain operative.

d) Pressure relief valves shall be so designed that the possibility of tampering will be minimized. Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment.

3.3. Connections for Flow Control (Filling, Withdrawal, Equalizing).

3.3.1 Shut off valves, excess-flow check valves, back flow check valves and quick closing internal valves, used individually or in suitable combinations, at container filling, withdrawal and equalizing connections, shall comply with 5.3.1.2 and 5.3.1.3.

3.3.2 Filling, withdrawal and equalizing connections shall be equipped with the appurtenances for the appropriate type and capacity of container and the service in which they are to be used. Cylinder valve outlet connections on all DOT cylinders from which vapor can be withdrawn, shall not be interchangeable with those used for liquid withdrawal.

3.3.3 Manual shut off valves shall be designed to provide positive closure under service conditions.

3.3.4 Excess flow check valves shall be designed to close automatically at the rated flows of vapor or liquid specified by the manufacturer. Excess flow valves shall be designed with a bypass, not to exceed a No. 60 drill size opening, to allow equalization of pressure.

3.3.5 Backflow check valves, which may be of spring loaded or weight-loaded type with in line or swing operation, shall close when flow is either stopped or reversed. Both valves of double backflow check valves shall comply with this provision.

3.3.6 The appurtenances specified herein above may be installed as individual components or as combinations completely assembled by the appurtenance manufacturer.

3.4 Liquid Level Gauging Devices

3.4.1 Liquid level gauging devices shall be provided on all containers filled by volume. Fixed level gauges or variable gauges of the slip tube, rotary tube or float types (or combinations of such gauges) may be used to comply with this provision.

3.4.2 Variable liquid level gauges shall be so marked that the maximum liquid level, in or percent of capacity of the container in which they are to be installed, is readily determinable.

3.4.3 The markings indicating the various liquid levels from empty to full shall either be directly on the system nameplate and on the gauging device.

3.5 Other Container Connections

Container openings, shall be equipped with a positive shut off valve in combination with an excess-flow valve.

**4.0 PIPING, FITTINGS AND VALVES.**

4.1. General

4.1.1 This section includes basic design provisions and material specifications for pipe, tubing, pipe and tubing fittings, valves used to connect container appurtenances with the balance of the LP Gas system.

4.2 Pipe

4.2.1 LPG fill line shall be seamless steel to ASTM A53 Sch 80

4.2.2 Distribution pipework shall be seamless steel to ASTM A53, Sch 40.

4.2.3 Final connections to equipment shall be soft copper tubes to BS 2871 Table X. Metal braided pigtails suitable for use with LPG.

4.3 Pipe and Tubing Fittings

4.3.1 Pipe joints in steel, brass or copper pipe shall be welded or brazed.

4.3.2 Fittings used at pressure higher than container pressure, such as on the discharge of liquid transfer pumps, shall be suitable for a working pressure of at least 350 psig (2.4 MPa gauge).

4.3.3 Fittings used with liquid LP-Gas, or with vapor LP-Gas at operating pressures over 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

4.3.4 Fittings for use with vapor LP-Gas at pressure not exceeding 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of 125 psig (0.9 MPa gauge).

4.3.5 Soldering or brazing filler material shall have a melting point exceeding 1,000 deg. F (538 deg. C).

4.4 Valves, Other than Container Valves

4.4.1 Pressure containing metal parts of valves (except appliance valves), including manual positive shut off valves, excess flow check valves (either manually or automatically operated), used in piping systems shall be of steel, ductile (nodular) iron, malleable iron or brass. Ductile iron shall meet the requirements of ANSI/ASTM A 395 or equivalent and malleable iron the requirements of ANSI/ASTM A 47 or equivalent. All materials used to include valve seat discs, packing, seals and diaphragms shall be resistant to the action of LP Gas under service conditions.

4.4.2 Valves shall be suitable for the appropriate working pressure, as follows:

a) Valves used at pressures higher than container pressure, such as on the discharge of liquid transfer pumps shall be suitable for a working pressure of at least 350 psig (2.4 MPa gauge). [400 psig (2.8 MPa gauge) WOG valves comply with this provision].

b) Valves to be used with liquid LP Gas, or with vapor LP-Gas at pressures in excess of 125 psig (0.9 MP a gauge), but not to exceed 250 psig (1,.7 MPa gauge), shall be suitable for a working pressure of at least 250 psig (1.7 MPa gauge).

c) Valves (except appliance valves) to be used with vapor LP Gas at pressures not to exceed 125 psig (0.9 MPa gauge) shall be suitable for a working pressure of at least 125 psig (0.9 MPa gauge).

4.4.3 Manual shut off valves, excess flow check valves and backflow check valves used in piping systems shall comply with the provisions for container valves.

4.4.4 Emergency shut off valves shall be approved and incorporate all of the following means of closing.

a) Automatic shut off through thermal (fire) actuation. When fusible elements are used they shall have a melting point not exceeding 250 deg.F (121 deg. C).

b) Manual shut off from a remote location. Manual push button switches for solenoid valves.
c) Manual shut off at the installed location.

4.4.5 Solenoid valves in kitchen shall be intrinsically safe and explosion proof construction suitable for 220V AC power supply.

## 5.0 INSTALLATION OF PIPE, TUBING, PIPE AND TUBING FITTINGS, VALVES AND HOSE.

5.1 When joints are welded or brazed:

a) The pipe shall be Schedule 40 or heavier (for steel).

b) The fittings or flanges shall be suitable for the service in which they are to be used.

c) Brazed joints shall be made with a brazing material having a melting point exceeding 1,000 deg. F (538 deg. C).

5.2 Gaskets used to retain LP-Gas in flanged connections in piping shall be made of metal or other suitable material confined in metal having a melting point over 1,500 deg. F (816 deg. C) or shall be protected against fire exposure, except that aluminium O- rings and spiral wound metal gaskets are acceptable. When a flange is opened, the gasket shall be replaced.

5.3 Piping in systems shall be run as directly as is practicable from one point to another and with as few restrictions, such as ells and bends.

5.4 Provision shall be made in piping including interconnecting of permanently installed containers, to compensate for expansion contraction, jarring and vibration, and for settling. Where necessary, flexible connectors may be used. The use of nonmetallic pipe, tubing or hose for permanently interconnecting such containers is prohibited.

5.5 Metallic piping outside buildings may be underground or above ground or both. Above ground piping shall be well supported and protected against physical damage. Where underground piping is beneath drive ways roads or streets, possible damage by vehicles shall be considered.

5.6 Underground metallic piping shall be protected against corrosion as warranted by soil conditions. Corrosion protection shall comply with the following:

a) Underground piping shall be protected as needed with a suitable coating to retard the effects of the corrosion conditions existing in the local soil. Coated pipe shall extend at least 6 in (152 mm) above ground on all risers
b) When dissimilar metals are joined underground, an insulating fitting shall be installed to electrically isolate them from each other.
c) LP Gas piping shall not be used as a grounding electrode.

5.7 A hydrostatic relief valve or a device providing pressure relieving protection shall be installed in each section of piping in which liquid LP Gas can be isolated between shut off valves so as to relieve the pressure which could develop from the trapped liquid to a safe atmosphere or product retaining section.

5.8 After assembly, piping systems shall be tested and proven free of leaks at not less than the normal operating pressure. Test shall not be made with a flame.

## 6.0 LPG VAPORIZERS

6.1 Vaporizers shall be indirectly electrically heated, FM approved, meeting the requirements of NFPA 58 and shall be suitable for Class 1, Division 2, Group D, hazardous locations as verified per FM approval requirements.

6.2 Vaporizers shall be suitable for outdoor installation and shall incorporate suitable automatic means to prevent liquid from passing from the vaporizer to the vapour discharge piping.

6.3 Vaporizers shall be equipped, at or near the discharge, with a spring-loaded pressure relief valve providing a relieving capacity as dictated by NFPA 58.

6.4 Direct fired vaporizers with an inside diameter of more than 152mm shall be constructed in accordance with the applicable provision of the ASME code for a design pressure of 1,700kPa. Those having an inside diameter of 152mm or less shall be exempted from the ASME code but still be constructed for a minimum design pressure of 1,700 kPa.

## 7.0 GAS LEAK DETECTION SYSTEM

A gas leak detection system shall be installed to monitor for gas leaks at different locations of the gas network.

7.1 Control Panel

a) The central control panel shall be located in the entrance of the building and shall easily be accessible in the event of an emergency.

b) The central panel shall have a modular design incorporating input alarm/display module for each gas detector. Each channel shall have indication for low alarm at 15% LEL, high alarm at 30% LEL and fault at 0-100% LEL indicator. Main LPG supply shall be shut off at 30% LEL indication.

c) The concentration of the gas shall be displayed on a common indicator with selector switches to display the concentration of the desired channel or zone indicator.

d) Below the gas control panel is the system control panel which shall have the following indications:

- AC healthy
- DC healthy
- Sprinkler on
- Gas pressure low
- Gas pressure high
- Gas solenoid valve operated
- Common fire signals
- Gas leak high

The panel shall have the following switches:

- Sprinkler manual operate
- Gas manual shut off
- Test lamp
- System reset

7.2 Gas Detectors

The gas detectors shall use a pellistor sensor to detect flammable gases and vapors. The sensor shall be housed in a stainless steel, flame proof housing, fitted onto an explosion proof junction box (Tank Area).

7.3 Sounder Flasher

A sounder cum flasher unit shall be installed in the vicinity of the panel located in a visible area.

7.4 Cables

MICC cables or FP 200 cables of at least 1.5 sq. mm area shall be used to interconnect between each detector and the control panel.

7.5 Logic of operation

When low level gas leak is detected in any zone, local internal alarm and indication shall show on the control panel. When high level gas leak is detected in any zone, the following sequence shall occur:

a) The solenoid valve in the gas distribution channel shall be closed. b) External alarm shall be operated.

Connection to the fire alarm system:

In the event of a fire alarm signal, the following sequence shall occur:

a) The solenoid valve in the gas distribution channel shall be closed. b) The sprinkler system shall operate.

In the event of an emergency, it shall be possible to bypass the automatic system and operate the system manually, this shall include:

a) Manual shut off / on of the gas.
b) Manual operation of the sprinkler system on / off
c) Manual reset

## 8.0 PERSONNEL

The LPG system shall be installed by specialized personnel supervised by a specialized engineer.

## 9.0 PAINTING AND IDENTIFICATION

All pipe work, pipe supports and brackets shall be painted with 2 undercoats and 2 finishing coats of approved paint.

LPG piping shall be painted with a specific colour different than other pipes. Orange or yellow colours are recommended. Valves shall also be painted. Direction arrows to indicate the flow of gas in the system shall be painted.

## 10.0 TESTING AND COMMISSIONING

The system in parts and as a whole shall be tested to ensure that it will operate safely, without leaks and to the applicable specifications.
Commissioning of the system shall be carried out to demonstrate that all the equipment and the whole system are in good working order.
The LPG contractor shall accommodate any additional testing required by authorities such as Civil Defense in order to obtain their acceptance of the system.

The gas network shall be leak tested using gases such as nitrogen or argon. Oxygen or flammable gases will not be used. The leak test shall include all the different pressure stages of the system including:

a) The filling line operating pressure up to 20 bar.
b) The tank and high-pressure stage operating pressure 16.5 bar
c) The first stage regulator operating pressure 1.5 bar.
d) The second stage pressure, operating pressure 37 mbar.

Test pressure shall be at least 1.5 times the operating pressure. The leak test duration shall be 1 hour. The specified test pressure shall be monitored for a minimum of one hour during which the soap water method shall be used to leak test every joint. If no leak is detected and the pressured gauge indicates no drop in the test pressure then the system will be proven to be leak free.
If a leak is found, the leaking joint shall be repaired or the leaking equipment shall be replaced. The testing procedure shall be repeated to prove the complete system as leak free.
A test report shall be submitted to the consultant for approval.

Contractor to be considered additional emergency key switch for each kitchen inside a lockable panel in the common corridor of each floor. The emergency key switch must override the gas switch inside the kitchen. (Show the location of the emergency switch enclosure for each floor as per the attached drawing).

# SECTION 10
# NOISE AND VIBRATION CONTROL REQUIREMENT

# NOISE AND VIBRATION CONTROL REQUIREMENT

## 1. PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Requirements for noise and vibration control of Mechanical, Electrical, and Public Health (MEP) services.

B. To prevent transfer of noise and vibration to occupied spaces and to prevent sound insulation between spaces being degraded by services penetrations.

C. This Specification shall be read in conjunction with all Equipment Data Sheets and Schedules and all relevant Contract Drawings and Specifications.

D. Where there are discrepancies between this Specification and other Specifications, with regard to noise and vibration control, this Specification shall take preference, unless there are specific technical or practical reasons that must take precedence over this Specification, or unless otherwise instructed by the Employer or Engineer.

### 1.02 REFERENCES

A. References shall include, but not necessarily be limited to, the following:

ASID – American Society of Interior Designers (United States).

AHRI – Air-conditioning, Heating and Refrigeration Institute (United States).

ANSI – American National Standards Institute (United States).

ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers (United States).

ASTM – American Society for Testing and Materials (United States).

BCO – British Council for Offices (United Kingdom).

BREEAM – Building Research Establishment Environmental Assessment Method (United Kingdom).

BSI – British Standards Institute.

CENELEC – European Committee for Electro technical Standardization.

CIBSE – Chartered Institute of Building Services Engineers (England).

DIN – Deutsches Institute fur Normunge. V. (Germany).

EC – European Commission.

EN–European Norms.

EPA – Environmental Protection Agencies (United States & United Kingdom).

HVCA – Heating & Ventilating Contractors' Association.

IEC – International Electrical Commission.

ISO – International Organization for Standardization

LEED – Leadership in Energy and Environment Design (United States).

NFPA – National Fire Protection Association (United States).

SMACNA – Sheet Metal and Air Conditioning Contractors' National Association.

WHO – World Health Organization.

**1.03 CONTRACT OR REQUIREMENTS**

A. Tender Proposals:

The Contractor shall submit at the time of Tender the names and qualifications of the noise and vibration control manufacturers. If a manufacturer is not one of the pre-approved manufacturers, the submittal shall be accompanied by a complete catalogue of that manufacturer's products and samples of each proposed vibration and/or noise control hardware.

The Contractor shall supply at the time of tender the design sound power levels (L win dBre10-12W) for the entire MEP device, or the design sound pressure levels (L pindBre2x10-5Pa) at specified distances from each side of the device. This information shall be submitted for each air moving, noise-generating and vibration-generating device including all those described in this Specification and all others as described in the Contract Documents and related Specifications.

If the actual sound power or sound pressure generated by any device exceeds the levels for the equipment specified in the Contract Documents and related Schedules and Specifications, the Contractor shall include in its price the cost for modifications to compensate for the extra noise or vibration at no additional expense to others. Any such modification shall be subject to the review and approval by the Engineer.

B. Tender Submissions:

The Contractor shall submit detailed information on noise and vibration levels associated with each equipment item to the Engineer prior to ordering plant and the noise and vibration control hardware. This information shall demonstrate that these elected plants and attenuating hardware can achieve the specified noise and vibration criteria under the required design duties.

Prior to Contract Award, the Tendered shall provide, as a minimum, the following information with the Tender:

A statement of compliance with all related Specifications. Manufacturer's details of the products and systems being offered.

Test certificates (in English or accompanied by a full English translation) from an independent acoustic test laboratory to show compliance with the specified acoustic performances for the products offered. Failing this, the Tendered shall allow in the Tender for the expense of such testing as necessary to show compliance with this Specification and all other related Specifications.

After Contract Award, the Supplier shall provide, as a minimum, the following information:

Shop drawings showing the methods for installation of all equipment and associated noise and vibration control measures.

Details for the complete noise and vibration control systems including frames, seals, isolators, panels, etc., and all materials and methods for acoustically sealing and fixing all elements and components.

C. Laboratory Testing:

Certified and verifiable tests shall be provided in accordance with the standards stated in this Specification and all other related Specifications. Laboratory measurements shall be obtained from an independent acoustic test laboratory, as approved by the Engineer, under test conditions on representative samples (including joints, seals, bases, isolators, attenuators, etc.) of the products and systems being offered.

Test laboratories shall have certifications for their facilities, including instrumentation, traceable to any of the following (or acceptable equivalent):

NAMAS (National Measurement Accreditation Service)

UKAS (United Kingdom Accreditation Service)

NVLAP (National Voluntary Laboratory Program)

NIST (National Institute of Science and Technology)

DINENISO/IEC17025 General requirements for the competence of testing and calibration laboratories.

Measurements obtained in accordance with equivalent standards acceptable to the Engineer shall also be permitted, subject to their applicability.

Where existing data is available from are cognized independent test laboratory it shall be considered acceptable providing the tests have been carried out for the exact same product and system offered.

If test data is not available, within 8 weeks of the award of contract, or other period to be advised by the Engineer, tests shall be under taken in accordance with the specified standards to demonstrate that the proposed products and systems, together with the associated elements shown in the relevant Contract Drawings and described in all related Specifications, comply with the specified performance requirements.

D. Mock-up Testing:

Where required and stated in the Contract Documents, Mock-up tests shall be carried out for Air Handling Units (AHUs), Fans, Fan Coil Units (FCUs), Constant Volume Units (CVs), Variable Air Volume Units (VAVs), Variable Refrigerant Volume Units (VRVs) and any other MEP equipment as advised by the Engineer, to confirm compliance with the acoustic performance requirements, as described below and in accordance with all other related Specifications.

The Mock-up room shall be constructed on site, at the manufacturer's or Subcontractor's factory, or within an acoustic test laboratory. The relative merits of each option shall be evaluated to ensure the following specified parameters are achieved.

Are preventative unit of each proposed size shall be tested.

The unit(s)selected, shall be from the upper volume range for each size.

The unit(s) shall be complete with filters, coils, low velocity duct work, plenum box and diffusers, etc., to simulate a typical room/space layout.

All details of the proposed units and duties shall be submitted to the Engineer for comment and acceptance.

The Mock-up room shall have the same nominal floor area and height as the area to be served by that unit. The room / space shall be provided with a false ceiling of the same type as proposed for the project, along with typical weakness stop simulate return air paths. Return air light fittings, diffusers, grilles and floor finishes shall be fitted, as proposed for the Project, with the unit in its installed position within the building. Shop Drawings shall be submitted to show the room/space in plan and section along with the unit for comment and acceptance by the Engineer.

Where applicable, the Subcontractor shall ensure that noise from the discharge/outlet side of the unit does not affect acoustic readings in the Mock-up room.

Prior to recording any noise levels, the background noise in the Mock-up room shall preferably be at least 10dB below the Mock-up room noise criterion, with a minimum of 6dB below.

The unit shall be set at its design speed and run on a 3hour on/1hour off basis for a minimum of 200hours prior to any acoustic testing, or other operational timing sequence to be advised by the Engineer.

The units shall be operated at the agreed air volumes, which shall be verified by separate measurement and accepted by the Engineer.

For VAV units, noise levels generated when the damper is closed to half flow at the same total inlet pressure shall also be measured.

A minimum of 4 Nos. measurements shall be taken in the Mock-up room, which shall be at least 1m from a wall, or other measurement positions at least 1.2m above the floor. No individual measurement shall be exceeded by more than 2dB and the logarithmic average of all the measurements shall not exceed the Mock-up room noise criterion.

Measurements shall be carried out by a competent person using a sound level meter and octave band filters to complying with BSEN60651 Type 1 which shall be calibrated before and after use.

The Subcontractor shall provide are port listing all test details, and measurements, to show compliance with the Specifications.

A full method statement shall be prepared along with Shop Drawings, to show the proposals for the Mock-up room and shall be submitted to the Engineer for acceptance at least 20 working days prior to the day of the tests, or other period to be advised by the

Engineer.

E. Site Testing:

All noise and vibration site tests and measurements shall be carried out in accordance with Testing, Adjusting and Balancing for HVAC.

All other acoustic tests and measurements shall be carried out in accordance with Acoustic Performance Requirements.

Contractors and Manufacturers Responsibilities for Tests:

Noise data for items of plant not covered in this Specification or other related Specifications shall also be provided by the Manufacturer or Supplier, to allow the Contractor to demonstrate the following:

- Confirm that the individual items of equipment offered shall achieve the specified noise and vibration criteria in each space.
- Identify which individual items of equipment offered require additional noise and/or vibration control measures to ensure that the specified noise and vibration criteria shall be achieved in each space.

All acoustic testing referred to in this Specification shall be allowed for in the Contractor's Tender. A Method Statement for the test shall be provided in writing, not less than 14 working days before the test, or other period to be advised by the Engineer, for final acceptance by the Engineer. The Engineer shall be advised of the date of the test, in writing, not less than 20 working days before the test, or other period to be advised by the Engineer. The Contractor shall be responsible for testing and securing approval for operation from the responsible legal authority having jurisdiction per any item in this Specification and all other related Specifications.

The Contractor shall responsible for reviewing this Specification and considering any special requirements from officials responsible for enforcing applicable codes and standards. Where necessary, the Contractor shall make corrections, changes and additions to the proposed methods and procedures for testing at no increase in the Contract Price.

The Contractors hall be responsible for verifying the completeness of the installations and the overall suitability of the equipment to meet the intent of this Specification and all other related Specifications. Any additional equipment needed to meet the intent of this Specification, even if not specifically mentioned here in or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Employer or Engineer to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.

During any Laboratory, Mock-up or Site Tests, if any pure tones are audible, or of there is doubt as to whether a pure tone exists, discrete frequency components tests shall be undertaken. These shall be assessed as being significant and present in a one-third octave band if the measured sound power or pressure level in that one-third octave band exceeds the arithmetic average of the measured sound power or pressure level in the two adjacent one third octave bands by at least the values stated below:

| **Discrete Frequency Sound Level Difference Sound Pressure Levels in dB Leq(re2x10-5Pa) Third Octave Band Centre Frequency (Hz)** | | | | | |
|---|---|---|---|---|---|
| <100 | 125 | 160 | 200 | 250 | 315-10k |
| 6dB | 5dB | 4dB | 3dB | 3dB | 2dB |

If measurable ton also uncharacteristic exist in the tested sound levels (as determined by the discrete frequency test specified above), the Contractor shall make every effort to eliminate them. Failure to achieve this shall require attenuation of the pure tones by the amounts for each octave band given below:

| **Pure Tone Attenuation Requirements Sound Pressure Levels in dBLeq(re2x10-5Pa) Octave Band Centre Frequency (Hz)** | | | | | |
|---|---|---|---|---|---|
| 63 | 125 | 250 | 500 | 1k | .2k |
| 3dB | 5dB | 9dB | 12dB | 14dB | 15dB |

**1.04 NOISE CONTROL REQUIREMENTS**

**A. Acoustic Flexible Connections:**

Where flexible connections are provided between a fan and its associated attenuator/silencer (and at other positions shown on the Contract Drawings), they shall be complete with the noise containment properties of the adjoining duct work system inclusive of any specified lagging.

Flexible connections shall typically be structured from sound barrier mat having a minimum superficial density of at least 5kg/$m^3$.

Flexible connections shall be at least 50 mm long, straight but not rigid, with no offset in order to prevent turbulence.

The acoustic flexible connections shall be measured in attest laboratory, accepted by the Engineer, and designed to achieve the minimum performances tabulated below:

| Sound Reduction Index/Sound Transmission LossOctave Band Centre Frequency (Hz) | | | | | |
|---|---|---|---|---|---|
| 125 | 250 | 500 | 1k | 2k | 4k |
| 7 | 8 | 10 | 13 | 13 | 13 |

The above performances shall be verified by measurements in a test laboratory in accordance with the following, or acceptable equivalent, standards, which shall be approved by the Engineer:

ASTME90: Standard Test Method for Laboratory Measurement of AirborneSound Transmission Loss of Building Partitions and Elements.

ISO10140-1:2010 Acoustics-Laboratory measurement of sound insulation ofbuilding elements –Part1: Application rules for specific products

**B. Acoustic Louvres:**

Where sown on the Contract Drawings, or specified elsewhere in the Contract Documents, or required as an additional means to control noise break out to the environment, acoustic louvres shall be purpose -built units constructed by a specialist manufacturerwith a minimum of 10 years of experience in acoustic louvre

manufacture.
The acoustic louvres shall be constructed as single-banked or double-banked systems, as required to meet the acoustic performance requirements, and designed to prevent theingress of rain and sand, under normally encountered meteorological conditions in the Kingdom of Saudi Arabia.

Sound transmission loss (STL) or sound reduction index (SRI) test data shall be providedfor acoustic louvers identical in every significant detail to those proposed, for acceptanceby the Engineer, before an order is placed / This refers to air flow velocity, pressure dropand, as far as is reasonable, entry and exit conditions, to demonstrate that the following performance is achieved:

| Sound Reduction Index/Sound TransmissionLoss | | | | |
|---|---|---|---|---|
| 250 | 500 | 1k | 2k | 4k |
| 15 | 18 | 27 | 30 | 33 |

The above STL or SRI performances shall be verified by measurements in a testlaboratory in accordance with ISO10140 -1, ASTME90 or acceptable equivalent standards which shall be approved by the Engineer. Any extrapolation or calculation used to produce the data shall be clearly stated. STL or SRI test data shall include either,the static insertion loss and regenerated noise for the given air flow conditions, or both static and dynamic insertion losses for the given air flow conditions.
The louvre frames shall be constructed from a suitable gauge of galvanized mild steel, or aluminum, supporting louvre blades of similar material. The acoustic material in the blades shall have a density of not less than 48 kg/$m^3$, be inert, rot and vermin proof, non-hygroscopic and composed of incombustible mineral fiber, faced with mineral fiber tissue and retained on the lower blade by perforated, galvanized mild steel or aluminum.
When the louvres are actually manufactured, each unit shall be shop assembled as a whole unit unless the Contractor or Engineer instructs to the contrary.
If necessary, louvres shall be supplied with an integral bird screen of galvanized mild steel or aluminum mesh, fixed in its internal face. The mesh pitch shall be a maximum of25 mm.
The louvres shall be supplied complete with all necessary fittings, flanges etc., for fitting in to the louvered openings as required by the Contractor or Engineer.

All gaps between the outside of the louvre frames and walls or ducts shall be made good and sealed with a heavy grout and/or non-hardening, dense mastic.

**C. Acoustic Panels:**

Where shown on the Contract Drawings, or specified elsewhere in the Contract Documents, or required as an additional means to control noise break out, acoustic panelsshall be fitted to walls and, if required, ceilings/soffits. These treatments apply to large plena, plant rooms and builders work shafts associated with, but not limited to, chiller plant rooms, generator rooms, boiler/dilution flue rooms, transformer rooms and exhaustfan rooms. These panels canal so be used to build acoustic enclosures around noisy plantitems such as fans, motors, pumps and other plant equipment.

The internal surfaces of the enclosure panels shall be designed to achieve the minimum

performances tabulated below using a Type Amounting as described in ASTME795:

| Random Incidence Sound Absorption Coefficient(α) Octave Band Centre Frequency (Hz) | | | | | |
|---|---|---|---|---|---|
| 125 | 250 | 500 | 1k | 2k | 4k |
| 0.50 | 0.70 | 0.90 | 0.90 | 0.90 | 0.90 |

The above performances shall be verified by measurements in a test laboratory in accordance with the following, or acceptable equivalent, standards, which shall be approved by the Engineer:
ASTMC423: Determination of Sound Absorption Coefficients in a Reverberation Room.

ASTME795: Standard Practices for Mounting Test Specimens During Sound Absorption Tests.

ISO354: Acoustics-Measurement of sound absorption in a reverberation room. The acoustic enclosure panel systems (but excluding the effects of services penetrations) shall be designed to achieve the following minimum performance when measured in a test laboratory, accepted by the Engineer, in accordance with ISO10140-1, ASTME90 or acceptable equivalent standard which shall be approved by the Engineer:

| Sound Reduction Index/Sound Transmission Loss Octave Band Centre Frequency (Hz) | | | | | |
|---|---|---|---|---|---|
| 125 | 250 | 500 | 1k | 2k | 4k |
| 16 | 26 | 32 | 32 | 32 | 31 |

Where specified, the acoustic enclosure panels shall be constructed from galvanized mild steel sheet atleast1.6 mm thick (16 swg) or as otherwise specified.

The absorbent internal lining shall be faced with glass fiber cloth or other infill protection membrane and retained by perforated galvanized mild steel sheet having an open area preferably in excess of 23%, with the whole panel not less than 50 mm thick. Provision shall be made inside the panel to prevent settling of the acoustic medium.

Full allowance shall be taken of any loss of insulation due to doors, windows, ventilation openings through louvres/vents and panel joints.

Sections shall be designed to allow unskilled personnel to easily disassemble and reassemble the parts without compromising the acoustic performance.

The Supplier shall ensure that the assembled enclosure is designed and constructed to with stand site operating conditions such as wind or sand storm loads, roof-mounted plant, etc., and to be suitably weather proofed for use outdoors.

**D. Air Cooled Condensers and Similar Types of Cooling Equipment:**

Where shown on the Contract Drawings, or specified elsewhere in the Contract Documents, Air Cooled Condensers, Dry Air Coolers or similar types of cooling equipment shall be independently tested, in accordance with AHRI, ISO, Euro vent or other accepted equivalent standards, in order to provide octave band noise data as stated elsewhere in this

Specification and/or other related Specifications. The tests shall be carried out for the full range of operational volumes at pressure drops equivalent to those expected in the installed systems.

To ensure minimal tonal noise is generated from the fan operations, electronic noise filters or other noise-attenuating measures shall be provided. The noise filters shall be factory-fitted items that consist of heavy copper coils inside a weather proof IP55 enclosure where the copper coil will cut voltage peaks out of the controller and smooth out tonal noises. Each noise filter shall have its dedicated capacitor supplied that will act as a compensator for the filters.

Based on the acoustic test data provided, noise and vibration attenuation requirements shall be incorporated by the Contractor as required to achieve the specified acoustics, noise and vibration.

**E. Air Handling Units (AHUs), Fresh Air Handling Units (FAHUs) and Computer Room Air Handling Units (CRAHs):**

Where shown on the Contract Drawings, or specified elsewhere in the Contract Documents, all AHUs, FAHUs, CRAHs or similar types of equipment shall be independently tested, in accordance with AHRI, ISO, Euro vent or other accepted equivalent standards, in order to confirm compliance with the octave band sound power levels (LwindBre10-12W) specified in the Schedules and other related Specifications. The tests shall be carried out for the full range of operational volumes at pressure drops equivalent to those expected in the installed systems. The in-duct sound power levels specified shall include the effect of regenerated noise from attenuators integral to the AHU.

Based on the acoustic test data provided, noise and vibration attenuation requirements shall be incorporated by the Contractor as required to achieve the specified acoustics, noise and vibration criteria.

The casing insulating material shall be a thermal, sound retarding and absorbing media which is non-combustible, non-hygroscopic, inorganic, mildew resistant vermin proof and shall comply with the requirements of BS476-6 and BS476-7, or other acceptable equivalent standard advised by the Engineer. The media shall be securely fixed to internal surfaces with suitable adhesives or mechanical fixings such that voids are eliminated cold bridging is avoided and to ensure that it is held rigid during shipment. The insulation shall be totally encapsulated to prevent migration of particles into the airstream.

The minimum thickness of insulation shall be 25 mm for rigid polyurethane foam or 50mm for units insulated with mineral fibre. The insulation thickness shall also be of adequate thickness to ensure that condensation does not for month ceasing and to achieve a minimum overall thermal resistance for external air handling units or for those located within naturally ventilated plant rooms of 1.0m²C/W and 1.25m²C/W for internal units. (BSEN1886 Table 5 Class T3). Polyurethane insulating materials are to be CF and HCFC free and blown using agents with an ODP of zero.

The Sub contractor shall establish insulation thicknesses based on the worst combination of external and internal conditions.

The insulation shall be either naturally impermeable to water or provided with a continuous vapour barrier with due consideration given to insulation edges and cold bridges.

**F. Air Terminal Devices (Miscellaneous):**

Noise levels generated by air terminal devices, including Grilles, Registers and Diffusers (GRDs), shall be specified in the schedule of air terminal devices either as limiting sound power levels or as room noise level selection figures. Where no limiting sound power levels are specified, the air terminal devices shall be chosen to achieve a noise rating at least 10dB less than the specified room noise criterion for the total number of terminal devices serving the space.

The noise data described above shall be derived from actual tests performed using devices similar in every significant detail to those proposed and operating under the same conditions as those proposed, e.g. in terms of air flow velocity, pressure drop, angle of diffuser blades, volume control damper positioning and connecting duct work geometry.

All diffuser and grille plenums shall be constructed to suit the Specialist Suppliers' requirements. In general supply diffusers shall be fitted with purpose made plenum boxes to ensures table air discharge flow patterns under all flow specified conditions. Spigot connection sizes and their associated duct work connections shall be sized by the Sub-Contractor such that the specified room noise criteria are not exceeded.

Where grilles and diffusers are used for return air in to ceiling voids purpose designed acoustic plenums shall be provided in positions as indicated on the Contract Drawings.

In the event of any installed terminal devices failing to meet the specified room noise criteria, the Contractor shall carry out remedial works or provide replacement units, to the satisfaction of the Engineer, at no extra cost.

**G. Chillers and Cooling Towers:**

Noise attenuation requirements for all chillers, cooling towers and associated equipment shall be incorporated by the Contractor, as required, to achieve the specified acoustics, noise and vibration criterion.

Floating floors shall be considered by the Contractor, as required, in accordance with Section 096248 (Floating Floors).

**H. Constant Volume Units (CVs), Fan Coil Units (FCUs), Variable Air Volume Units (VAVs) and Variable Refrigerant Volume Units (VRVs):**

Suppliers of CVs, FCUs, VAVs and VRVs shall provide suitable acoustic data in order to determine compliance with the specified acoustics, noise and vibration criteria.

Casing radiated levels shall be a combination of noise from the air intake opening and the noise from the unit casing. The designs shall ensure that the motors are adequately isolated from the unit casings to ensure that electrically induced vibration does not result in excessive noise radiation from the units.

All noise data shall account for the specified external static pressures along with all coil/filter losses, etc., as free flow operation is not relevant. The designs shall also ensure that the motors are adequately isolated from the unit casings to ensure that electrically induced vibration does not result in excessive noise radiation from the units.
Unless otherwise agreed, the Sub-Contractor shall arrange for independent acoustic laboratory and/or acoustic mock-up performance tests to be carried out on one or more typical units, as selected by the Engineer, under taken in accordance with all relevant Clauses of this Specification and other related Specifications.

In-duct sound power levels (LwindBre10-12W) shall be measured at the air inlet and outlet of the unit (after attenuation if necessary). Casing-radiated sound power

Levels shall also be measured and reported separately. Noise data shall be provided for low, medium and high design fan speeds. The noised at a shall be obtained in accordance with the following, or other accepted equivalent standards, which separate casing - radiated / in let noise from discharge / outlet noise:

AHRI Standard 260: Sound rating of ducted air moving and conditioning equipment.

BS4856 - 4: Methods for testing and rating fan coil units, unit heaters and unit coolers – Determination of sound power levels off a coil unit, unit heaters and unit coolers using reverberation rooms (2nd Method).

ISO 3741: Acoustics –Determination of sound power levels of noise sources using sound pressure - Precision methods for reverberation rooms. If tests are carried out to ISO 3741 (2nd Method -ducted discharge), the duct end correction shall be calculated using ISO 5135: Acoustics –Determination of sound power levels of noise from air - terminal devices, air - terminal units, dampers and valves by measurement in a reverberation room.

In the event of an installed unit failing to meet the specified acoustic performance, the Contractor shall include for provision of necessary remedial works or replacement units to the satisfaction of the Engineer.

**I. Duct and Pipe Acoustic Lagging:**

Cladding/lagging and thermal insulation requirements for ducts and pipes shall be incorporated as required, to avoid break-out or break-back of noise through duct work, and to achieve the specified room noise criteria.

Where acoustic cladding / lagging is necessary and is located on both sides of flexible duct work coupling, the coupling shall also be clad

The acoustic lagging shall be designed to achieve the following minimum performance when measured / rated in a test laboratory, accepted by the Engineer, in accordance with ISO 10140-1, ASTME90 or acceptable equivalent standard which shall be approved by the Engineer:

| Sound Reduction Index/Sound Transmission LossOctave Band Centre Frequency(Hz) | | | | | |
|---|---|---|---|---|---|
| 125 | 250 | 500 | 1k | 2k | 4k |
| 16 | 18 | 22 | 30 | 35 | 45 |

External pipe and duct acoustic lagging shall take the form of either of the following:

Construction using a minimum of 50mm (density 32kg/m3) fiber glass covered by a sound barrier material of adequate surface weight to resist the level of break-through envisaged (using dry construction techniques only).

Construction of a separate enclosure where by a support is taken from the duct work and the surface weight is again adequate to resist the expected break-through, or equivalent, all to the satisfaction of the Engineer.

The acoustic lagging shall be fixed to the duct wall using 100% coverage of fire-retardant adhesive. The lagging shall additionally be fixed using GI steel bands at not less than 600 mm centers. No pin type fasteners linking the external layer of the laggingto the duct wall shall be used. No fixings which pierce the duct wall shall be used.

The fire rating of the lagging shall comply with BS5588, BS8313 or accepted equivalent, and shall have a BS476 Class 1 surface spread of flame rating, unlessotherwise advised by the Engineer.

**J. Duct Acoustic Lining:**

Where additional measures are necessary to control duct-borne noise, acoustic duct lining shall be provided to provide the following minimum performance when measured in a test laboratory accepted by the Engineer, in accordance with ISO354, ASTMC423 or acceptable equivalent standard which shall be approved by the Engineer, using a TypeAmounting as described in ASTME795:

| Random Incidence Sound Absorption Coefficient(α)Octave Band Centre Frequency(Hz) | | | | | |
|---|---|---|---|---|---|
| 125 | 250 | 500 | 1k | 2k | 4k |
| 0.10 | 0.25 | 0.50 | 0.75 | 0.80 | 0.80 |

The acoustic duct lining shall be dry and free from off-cuts, dust, grease, solvents,etc.

When fitting the acoustic duct lining insulation, all junctions shall be tightly buttedtogether to prevent heat leakage.

If the acoustic duct lining changes from internal to external, there shall be a minimum overlap of 300mm.

The lining facing shall be factory applied except when a sheet metal facing is specified.

Adhesives shall be restricted to those having the approval to the appropriateauthority in relation to fire hazard and shall be used in accordance with themanufacturer's recommendations.

The acoustic duct lining insulation shall be supported against the surface by means of stud welded pins and speed clips. At corners, sheet metal angle scan be used to provide abutted edge (to overlap the insulation joints) or the acoustic duct lining insulation can be folded and compressed into the corners.

**K. Duct Attenuators:**

Duct attenuators shall be purpose-built units constructed by a specialist manufacturer witha minimum of 10 years of experience in sound attenuator manufacture.
Duct attenuators shall be provided as indicated on the drawings and to meet the performance specification given in the attenuator schedules and shall be rectangular orcircular (as required) in cross-section and shall be straight in length.

Where applicable, to prevent duct work and ceiling void penetrations reducing thesound insulation between adjacent rooms, cross talk attenuators shall be providedwhere indicated on the drawings. If common duct work feeds adjacent rooms, the Contractor's duct layouts shall be arranged to minimize the number of cross talk attenuators needed.

Insertion loss data shall be provided form tests under taken in accordance with ISO 7235: Acoustics – Laboratory measurement procedures for ducted silencers and air- terminal units-Insertion loss, flow noise and total pressure loss, or another acceptable equivalent standard approved by the Engineer. Any extrapolation or calculation used to produce the data shall be clearly stated. Tests shall be carried out for attenuators identicalin every significant detail to those proposed, for approval by the Engineer, before an order is placed. This refers to air flow velocity, pressure drop and, as far as is reasonable, entry and exit conditions, to demonstrate that the installed insertion losses required in theschedule are met. The insertion loss test data shall include either, the static insertion loss and regenerated noise for the given air flow conditions, or both static and dynamic insertion losses for the given air flow conditions.

Attenuator casings shall be constructed from galvanized steel sheet. Joints shall be longitudinal, lock-formed and mastic sealed during construction. End flanges shall be welded to the casings, and shall be supplied with slotted bolt holes or other fixing detailsas necessary. Casing thickness and flange construction shall be in accordance with HVCASpecification DW/144, but with a minimum thickness of 0.8mm.

Sound absorbent materials used within attenuators shall be to BS5422 (clause4), inert, incombustible, non-hygroscopic, rot and vermin proof and packed under not less than 5% compression to eliminate voids due to settling. The materials shall with stand an air passage velocity of 25m/s without surface erosion or other forms of material migration. The air ways shall be free from projections into the air stream. The material shall achieve.If special attenuators are required inducts serving hygienic areas, the filler material shall be totally encapsulated and sealed with melinex or Mylar film with a thickness of at least 38 microns. The encapsulated filler material shall be totally separated from the internal perforated baffles using a non-combustible, erosion-resistant, acoustic stand-off which must be factory installed.
Vapour barrier materials shall be resistant to chemicals as required for the application. Vapour barriers for use in aggressive atmospheres shall not exceed 0.07 mm thickness and be installed in a non-taut state. The material shall achieve Class ItoBS476: Part7, andshall not emit toxic or hazardous fumes if ignited.

Attenuator insertion loss data provided shall include for the use of the vapour barrier. The direction of air flow shall be clearly marked on the attenuator outer casing. The airwaysshall be free from projections into the airstream.
Attenuators for site connection shall be delivered with blocked ends, and beundamaged on completion of installation.
Rectangular attenuators splitter elements shall be round-nosed and stand vertically and be close fitting within the casing and, where required, be easily removable for cleaning.
Where required, access panels shall be fitted with effective air tight seals which shallretain their performance after repeated use.

Notwithstanding the above requirements, all duct attenuators shall be designed, manufactured and installed in accordance with Section 233319 (Duct Silencers).

**L. Fans:**

Noise attenuation requirements for fans shall be incorporated as required to achieve the specified acoustics, noise and vibration criteria.
The units shall be independently certified to the following standards, or acceptedequivalent standards to be advised by the Engineer:
AMCA Standard 301: Methods for Calculating Fan Sound Ratings fromLaboratory Test Data.
AMCA Publication 303 (R2012): Application of Sound Power Level Ratings forFans.
ANSI/AMCA Standard 300: Rever be rant Room Method for Sound Testing ofFans.

To minimize tonal noise generated by the fan operations, electronic noise filters shall be provided. These shall be factory fitted items that consist of heavy copper coils inside a weather proof IP55 enclosure where the copper coil will cut voltage peaks out of the controller and smooth out tonal noises. Each noise filter shall have its dedicated capacitor supplied that will act as a compensator for the filters.

Where additional means are required to control noise break out to the environment, fansshall be attenuated with purpose-built acoustic enclosures, as described in Clause 1.4c.

**M. Generator Exhaust Systems:**

Motors:
Noise attenuation requirements for motors shall be incorporated as required to achieve the specified acoustics, noise and vibration criteria.
The maximum A-weighted sound power levels for factory acceptance testing shall be specified in accordance with EN60034-9 (IEC60034-9) - Rotating electrical machines Noise limits, and shall not exceed the following “no-load” overall sound pressure levels (indBre2x10-5Pa) at 1m from any side of the motor:
Motors ≤ 22 kW ≤ 75 dBA Motors > 22 kW and ≤ 112 kW ≤ 80 dBA Motors > 112 kW ≤ 85 dBA
Where additional means are required to control noise break out to the environment, motors shall be attenuated with purpose-built acoustic enclosures, as described in Clause 1.4C.
All addition noise control requirements for Electric Motors shall be incorporated as specified in Section 260548-1 (Noise and Vibration Control of Electrical Systems).
Pumps:
Noise attenuation requirements for pumps shall be incorporated as required to achieve the specified acoustics, noise and vibration criteria.

Where additional means are required to control noise breakout to the environment, pumps shall be attenuated with purpose-built acoustic enclosures, as described in Clause1.4C.

**N. Transformers and Uninterrupted Power Supply (UPS) Systems:**

Transformers and UPS systems shall comply with NEMA (National Electrical Manufacturers Association) Standards Publication No.TR1-1993 (R2000) Transformers, Regulators and Reactors, or other accepted equivalent standards orpublications as advised by the Engineer.

Maximum permissible sound pressure levels (SPL's) at 1m from any side (or top) of each transformer shall not exceed the values specified below:

| Two-Winding Size (kVA) | Liquid-Immersed Distributed & Network Transformers | Dry-Type Self-Cooleder Sealed Transformers | Dry-Type Forced Ventilation Transformers |
|---|---|---|---|
| 0-1000 | ≤ 58 dBA | ≤ 65 dBA | ≤ 68 dBA |
| 1501-2000 | 61 dBA | 66 dBA | 69 dBA |
| 2001-3000 | 72 dBA | 68 dBA | 71 dBA |
| 3001-4000 | 74 dBA | 70 dBA | 73 dBA |
| 4001-5000 | 75 dBA | 71 dBA | 74 dBA |
| 5001-6000 | 76 dBA | 72 dBA | 75 dBA |
| 6001-7500 | 77 dBA | 73 dBA | 76 dBA |

The Specialist Manufacturers for Lifts/Elevators and Escalators shall be responsible for informing the Engineer of items concerning their packages for which the Main Contractor and/or the Electrical Contractor have responsibility. This shall include but not be limited to builder's work requirements, delivery times, temporary power and access requirements, power supply locations and electrical power for testing and commissioning.

Noise and vibration levels from escalators and lists shall comply with all requirementsspecified in Section 260548-1 (Noise and Vibration Control of Electrical Systems).

## 1.02 VIBRATION CONTROL REQUIREMENTS

**A. Air Cooled Condensers and Similar Types of Cooling Equipment:**

Rubber mounts or 'tico' pads shall be installed between the feet of the condenser and steel works or finished roof/floor finish level as a minimum. Vibration or spring type isolators shall not be provided unless the Engineer supplies specific information separately. If vibration/spring isolators shall be provided, pipe work shall use flexibleconnections to isolate the unit from rigid fixed pipe work. If used, spring isolators shallbe located below the support beams, and not the feet which only provide stability.

To ensure no significant tonal noise is generated from the fan operation, electronic noise filters shall be provided. These are factory fitted items that shall consist of heavycopper coils inside a weather proof IP55 enclosure where the copper coil will cut voltage peaks out of the controller and smooth out tonal noises. Each noise filter shall have its dedicated capacitor

supplied that will act as a compensator for the filters

B. **Air Handling Units (AHUs), Fresh Air Handling Units (FAHUs) and Computer Room Air Handling Units (CRAHs)**: Vibration isolation requirements shall be incorporated as specified in this Specification and Section 230548-1 (Vibration and Seismic Controls for HVAC).

**C. Compressors:**

All floor mounted compressors shall be bolted and grouted to Type 3 or Type 4 concrete inertia bases and supported on Type B or Type C isolators, as specified in Section 230548-1 (Vibration and Seismic Controls for HVAC). Drain lines and airlines shall be supported on Type A hangers, as specified in Section 230548-1 (Vibration and Seismic Controls for HVAC), for the first three supports. Thereafter,isolated pipe clamps shall be used to prevent vibration entering the structure.

**D. Chillers and Cooling Towers:**

Vibration attenuation requirements for all chillers, cooling towers and associatedequipment shall be incorporated by the Contractor, as required, to achieve the specified acoustics, noise and vibration criteria.

Notwithstanding the above requirements, vibration isolation shall be incorporated, as required, in accordance with Section 230548-1 (Vibration and Seismic Controls forHVAC).

**E. Constant Volume Units (CVs), Fan Coil Units (FCUs), Variable Air Volume Units (VAVs) and Variable Refrigerant Volume Units (VRVs):**

The designs shall ensure that motors are adequately isolated from the unit casings to ensure that electrically induced vibration does not result in excessive noise radiation fromthe units.

**F. Equipment without Motors or Pumps:**

Expansion tanks, de aerators, heat exchangers, water heaters, etc., without pumps ormotors which is floor-mounted, shall be supported on Type D, E or F mounts. Where piping on isolators is connected to these units the connection shall be made with a neoprene flexible connector.

Expansion tanks, de aerators, heat exchangers, water heaters, etc., without pumps or motors which are suspended, shall be supported on Type A or C hangers. Where piping on isolators is connected to these units the connection shall be made with a neoprene flexibleconnector.

**G. Expansion Joints or Arched-Type Connectors:**

The tie rod systems on expansion joints used for vibration isolation shall be designed to achieve the vibration isolation required across the joint. The tie rod fixings shall use rubber or neoprene bushed washers to prevent metal to metal contact throughout the normal range of movement of the joint.

**H. Fans:**

Fan plena, air mixing plena and package air handling plena shall be installed on Type 3, 4 or 5 inertia bases, furnished with continuous Type D, E or F mounts located at the entire perimeter of each base. The plenum manufacturer shall supply and furnish all factory fabricated panels, joiners, access doors, structural supports, channels, fasteners, sealing accessories,assembly drawings and all other items necessary for erection.

Coils and filters in built-up air handling units shall be supported from the housekeeping pads on neoprene pads. Any remaining gaps beneath the coil / filterframes shall be sealed air tight with approved non-hardening sealant.
Each floor-mounted fan or packaged air handling unit shall be mounted on a Type 2 steelbase or Type 3, 4 or 5 concrete inertia bases with Type B. C or I un-housed steel spring isolators. Drain pipes for air handling units shall be supported only from the isolated air handlingunit frame. The condensate shall drip in to a funnel that is supported from the floor orfloor drain. A gap of at least 50 mm shall be maintained between the end of the air handling unit drain pipe and funnel or floor drain.

Suspended fans and air handling units from overhead structures shall be hung on TypeB or C steel spring hangers, as specified in Section 230548 -1 (Vibration and Seismic Controls for HVAC).

Unless otherwise specified in the Vibration Isolator Schedule, the static deflection of the isolators shall be 50 mm. If the fan does not contain a frame with mounting brackets of suitable rigidity and strength, or if there exists an extreme over hang condition, then a structural steel base shall be used. Fans shall be suspended from above only if expresslynoted as such on the Contract Drawings or advised by the Engineer. Any required thrustrestraint shall only be by pre-compressed isolators.

**I. Flexible Couplings:**

Flexible couplings shall be fitted on connections to dynamic plant and equipment including circulating pumps, water pressure boosting sets and refrigeration plant andelsewhere as indicated on the Contract Drawings and instructed by the Engineer.

Couplings shall be suitable for the system fluid, temperatures and pressures and shallbe selected to minimize the transmission of vibration to the connecting pipe work.

Couplings shall be constructed from terylene rein forced neoprene, corrosion resistantmetal or other accepted equivalent material. Couplings shall be complete with flanged ends to match the pipe work system specification.

Vibration isolated restraining tie bars shall be provided on flexible couplings to refrigeration plant and other dynamic plant connections where recommended by the plantsupplier.

All flexible couplings shall be selected with a natural frequency remote from theexciting frequency of the plant to minimize the risk of fatigue failure.

**J. Flexible Hoses:**

Flexible hoses shall be fabricated from EDPM rubber covered with a stainless-steel braid and shall be suitable for use with the working fluid on which they are installed andfor the specified system working and test pressures.

Flexible hoses shall be provided with a self-sealing, quick-connect coupling as TEMAor accepted equivalent.

Flexible hoses shall be installed in accordance with the requirements and recommendations of the manufacturer, the HMSA and BSRIACOP11 / 2002

Flexible pipe hose connectors of corrugated metal, or rubber, neoprene or other flexible liner with braided metal or other similar internal or external reinforcing, and intended foruse without tie rods, shall have the minimum live lengths recommended by ASHRAE when used for anti-vibration purposes. When, however, the hose
connecters are used to connect equipment with high pressures > 16 bar (g), multiplegrooved couplings (MGC) shall be used. The guide lines tabulated below shall be considered for hose connections to different plant equipment.

| Equipment | Isolator Type |
|---|---|
| Pump connections (less than 16 bar(g) | Flexible connectors (FC) |
| Pump connections (greater than 16bar(g) | Multiple grooved couplings (MGC)to provide adequate |
| AHU connections, less than 80mm | Direct connection |
| AHU connections, 80 mm and greater | Flexible connector (FC) or multiplegrooved couplings to provide adequate vibration isolation |
| FCU connections less than 25 mm | Direct connection |
| FCU connections 25 mm and above | Flexible hose (FH) |
| Connections to expansion tanks, deaerators, heat exchangers, etc. | Multiple grooved couplings (MGC) to provide adequate vibration isolation |
| Connections to chillers, cooling towers and similar plant | Multiple grooved couplings (MGC)to provide adequate vibration isolation |

**K. Flexible Joints:**

Wherever the natural flexibility of the pipe work cannot practicably be used to accommodate differential expansion, Victaulic flexible joints shall be designed into asystem to cater for pipe movement, thermal expansion and contraction, providing thedesign of the installation complies with the manufacturer's recommendations and themovement limits of the joint are not exceeded.

**L. Flexible Pipe Connectors:**

Reinforced flexible pipe connectors shall be used where pipes are to be locatedadjacent to acoustically sensitive spaces needing to achieve ≤ NR35.
The correct selection of connector shall provide pipe flexibility so that isolators can function properly, protect equipment from strain due to misalignment and expansion orcontraction of piping, and to reduce noise and vibration transmission along the piping.

All flexible connectors require end restraint to counter act pressure thrust. Over extension

caused by pressure thrust on isolated equipment will cause failure which shallbe avoided.

Manufacturer's recommendations on restraint, pressure and temperature limits shall be followed. Flexible neoprene pipe connectors manufactured of multiple plies of nylontire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement.

Straight connectors shall have two spheres. Neoprene elbows shall be manufactured witha single sphere
forming the corner of the joint itself. Connectors up to and including 50 mm diametermay have threaded ends. Connectors 63 mm and larger shall be manufactured with floating steel flanges needed to lock the connector's raised face neoprene flanges.

All connectors shall be rated a minimum of 1000 kN/m2 at 105 ºC. All straight through connections shall be made with either flanged or screwed twin spheres proper lypre-extended as recommended by the manufacturer to prevent additional elongation under pressure.

Size300mmandlargeroperatingatpressuresabove650kN/m2 shall employ control cables with end fitting isolated from the anchoring plates by means of 12mm thick bridge bearing neoprene washer bushings designed for a maximum of 0.7kN/mm2.

Flexible pipe connectors of corrugated metal, or rubber, neoprene or other flexible linerwith braided metal or other similar internal or external reinforcing, and intended for usewithout tie rods, shall have the minimum live lengths tabulated below (as per ASHRAEguide lines) when used for anti-vibration purposes.

| Nominal Pipe Bore Diameter | Live Length |
|---|---|
| 0–65mm | 300mm |
| 80–100mm | 450mm |
| 125–250mm | 600mm |
| 300mm or greater | 900mm |

Note that the above live length applies to the end-to-end length for flanged flexiblerubber hose. For other types of hose, the live length applies to the overall end-to-endlength less the fitting length.

**M. Generators:**

Pipes and Valves:
Vibration isolation to all distributed ducted and piped services shall follow the requirements and the following additional requirements.

The table below recommends where Resilient Inserts (RI) within pipe clamps, neoprene hangers (NH), spring hangers (SH) and neoprene mounts (NM) shall beused for different building services.

| Service | Pipe Diameter | Isolator | Static |
|---|---|---|---|
| Heating | Less than 50mm | NH, NM | 8mm |
| | 50–150mm | SH, SM | 25mm |
| | More than 150mm | SH, SM | 50mm |
| Chilled Water | Less than 50mm | NH, NM | 8mm |
| | 50–150mm | SH, SM | 25mm |
| | More than 150mm | SH, SM | 50mm |
| Domestic Water | Less than 50mm | NH, NM | 8mm |
| | More than 150mm | SH, SM | 25mm |
| Heat Recovery | Less than 50mm | NH, NM | 8mm |
| | More than 150mm | SH, SM | 25mm |
| CondenserCooling | Less than 50mm | NH, NM | 8mm |
| | More than 150mm | SH, SM | 25mm |
| Rainwater | Less than 50mm | R | Not applicable |
| | More than 150mm | R | Not applicable |
| Sprinklers, Dry Risers/Vents, Hose Reels & Sanitary | All | RI | Not applicable |
| Compressed Air | All Steel | R | Not applicable |

The above requirements shall be read in conjunction with all other related Specifications, and the following specific requirements.

Within plant rooms, all pipes connected to equipment installed on spring vibration isolators shall be suspended, supported and guided by means of appropriate spring vibration isolators. This includes domestic water, heating, compressed air, hydraulic fluid, steam and chilled water/glycol pipes, etc. The only exclusions are roof and floor drains and sprinkler piping which shall be supported by Type SM isolators or hung from the structure on Type SH isolators.

The first isolator both upstream and downstream of equipment on springs shall have astatic deflection equal to 1.5 times that of the equipment isolators, up to a maximum of 50 mm.

The static deflection of the remaining SM/SH pipe isolators in the plant room shall be 25mm.

Piping in the plant room that is connected only to machinery installed on neoprene isolators shall be either supported from the floor on Type NM mounts or suspended from the structure on Type NH hangers.

Where a pipe run connects multiple items of equipment in the plant room the pipe isolators for the entire run shall be chosen to suit the connected equipment of greatest static deflection.

Piping, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes, or duct work installed on vibration isolators. It shall be supported on or suspended from the building structure.

Where pipes are gange dona trapeze the pipes shall rest on the trapeze and the trapeze shall be isolated from the structure with the appropriate isolators. Neoprene pipe riser guides shall be used where lateral restraint is required.
All pipes outside the plant room with a diameter greater than 50mm (including domestic water, sanitary sewer and HVAC pipes, excluding roof/floor drain pipes and vent pipes) shall be supported on Type SM isolators or suspended on Type SH isolators, for the first15m.
Outside plant rooms all HVAC, compressed air and domestic hot and cold-water pipeswith a diameter less than or equal to 50mm shall be isolated on Type NM and NH isolators for the first 15m. All drain pipes and vent pipes shall be isolated from the structure with closed cell neoprene, felt or glass/mineral fiber sleeves between the pipeand pipe clamp or with neoprene pads between the clamp and the structure.
When it is compressed, the sleeve shall be not less than 3mm in thickness. This provision shall apply to all piping not otherwise required to be installed on vibration isolators. In-line domestic water pumps and the surrounding piping shall be installed onisolators as described above.
Where pipes or flues rise in a vertical chase and are supported from a structure with TypeSH or NH isolators and require lateral bracing, Neoprene riser guides shall be mounted around the pipe to limit lateral movement and to prevent direct contact with the supporting structure.
Riser guides for isolated pipes and flues shall be Type NM mounts based on the verticaledge of a steel angle. The guide shall allow the pipe to move axially, but shall limit lateralmovement to ± 25mm.
Drainage pipe work, including rain water pipes and soil pipes located within spaces of NR35 or below shall be cast iron and shall be lagged and boxed-in. All pipe supports shall incorporate neoprene inserts with a minimum thickness of 1/10th of the pipe diameter.
Pipes, ducts, and their contents, or other services connected, shall be supported to avoidload on equipment items.
Flexible duct connectors at connections to fans or AHU's shall be a coated fabric with 200mm across a clear gap of 100mm.
The first five supports for duct work one it her side of the vibration source shall also be provided with vibration isolators equal in static deflection to that of the fan or AHU.
Electrical connections to equipment mounted on vibration isolation bases shall be made through flexible conduit which changes direction by at least 90° in a minimumlength of 25 conduit diameters.
Mineral insulated cables shall be looped through at least 360° at 75mm radius ordouble the permissible minimum radius, whichever is larger.
For conduit, where isolated containment is ganged on a trapeze it shall rest on the trapezeand the trapeze shall be isolated from the structure with the appropriate isolators.
Neoprene pipe riser guides shall be used where lateral restraint is required. The first three containment support vibration isolators shall provide the same static deflection as the equipment vibration isolators.

**N. Motors:**

Vibration isolation for Electric Motors shall be incorporated as specified in Section260548-1 (Noise and Vibration Control of Electrical Systems).

**O. Pumps:**

Rotating impellers of fans, pumps, chillers, etc., shall be balanced to standards not inferior to the balance quality grades of BS6861 (ISO 1940/1) or to the correspondingresidual eccentricities. The criteria shall apply to finished impeller and shaft assemblies at delivery. Where the balancing quality grades are not indicated they shall be to thefollowing minimum standards:

Grade G6.3: Where the product (impeller mass in kg x operating speed in Hz) isless than 250.
Grade G2.5: Where the product (impeller mass in kg x operating speed in Hz) isgreater than 250.
Grade G2.5: For impellers on equipment located in occupied areas, on fan convectors, packaged ventilation extract units and warm air heaters with motor power inputs greater than 100W, or canned rot or pumps or similar.
Impellers operating below 10Hz shall be balanced as if they operated at 10 Hz. Impellers of multi-speed or variable speed machines shall be balanced to thequality grade determined by their highest operating speed.
Vibration caused by fluid dynamic effects of any kind shall not be greater than the equivalent permissible vibration due to an impeller rotating at the frequency of the vibration.
Base mounted pumps ≥ 1.1kW shall be bolted and grouted to prefabricated, reinforced concrete inertia bases, which shall weigh ≥ 1.5 times the combined weight of the fluid filled pump (s) and motor (s). Minimum thickness of the concrete base shall be 225mmfor pumps < 2.2kW and 300mm for pumps > 2.2kW. Any rigid pipe elbows at the pumpsuction and discharge connections shall be supported from the inertia base. The inertia base shall be supported on Type B or Type C isolation hangers.
Base mounted pumps < 1.1kW and installed on floors above-grade shall be installed onType CIB concrete inertia bases with at least 4 Nos. Type D or Type E isolation mounts.
Base mounted pumps < 1.1kW and located on grade shall be mounted directly on a concrete housekeeping pad, and shall be supported on at least four Type D or Type E isolation mounts.
In-line pumps ≥ 1.1kW shall be supported by the piping which is isolated on Type B isolation hangers. If support is required below the pump, the pump shall be supported onType B or Type C isolation hangers.

In-line pumps < 1.1kW and adjacent pipe work shall be supported on Type A isolationhangers, unless other provisions of this Specification or other Specifications call for greater deflections.

If an associated circulation pump or chemical feed pump is to be mounted on the unit, and if the pump is ≤ 0.4 kW, the pump shall be mounted to the unit through Type H restrained isolation hangers. Such pumps > 0.4kW shall be supported from the building structure on Type A isolation hangers or Type E isolation mounts.
Circulation pumps > 1.2kW shall be supported on Type C concrete inertia baseswhich are supported on Type B or Type C isolation hangers. All connections to circulation pumps shall be with flexible connections.
Provide motor slide rails, pump base elbow supports, height saving brackets,equipment bolting provisions and isolators as required by the application.

Concrete inertia bases shall be formed in structural steel perimeter bases and reinforced to prevent flexure, misalignment of drive and driven unit, and stress transferal to the

equipment. Inertia bases shall be designed to the followingthicknesses:

| Motorize | Inertia Base Minimum |
|---|---|
| Less Than 15kW | 150mm |
| 15–39kW | 200mm |
| 40–69kW | 250mm |
| 70–99kW | 300mm |
| 100–149kW | 350mm |
| 150–199kW | 400mm |
| Above 200kW | 450mm |

Concrete inertia bases for pumps shall be sized to support the suction elbow of endsuction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

All inertia bases shall be sized to extend a minimum of 100mm beyond the base of the equipment, and in the case of belt-driven equipment, 100mm beyond the end of the drive shaft.

**P. Substations, Transformers and UPS Equipment:**

Vibration isolation for Substations, Transformers and UPS Equipment shall be incorporated as specified in Section 260548-1 (Noise and Vibration Control of Electrical Systems).

**Q. Vertical Transportation Systems:**

Vibration levels from escalators and lists shall comply with all requirements specified in Section 260548-1 (Noise and Vibration Control of Electrical Systems).

**1.03 SERVICES PENETRATION SA.**

General:

Where ducts or pipes penetrate the building structure it is essential to prevent such penetrations being either vibration flanking paths or sources of noise leakage. The penetrations shall, therefore, be sleeved with a 25mm thickness of mineral wool having a density of at least 50kg/$m^3$. Care shall be taken to seal any gaps by means of heavy grout and the hole shall be finished with a liberal application of dense non-setting mastic.

All openings around pipes and ducts in the structure surrounding the plant rooms and surrounding noise-critical spaces of NR40 and below, and any structure with a sound insulation requirement, shall be sealed air tight as described herein and on the drawings.This includes all slab penetrations and penetrations of noise sensitive walls indicated onthe architectural drawings. It also includes penetrations of all dry wall ceilings and concrete slabs suspended on isolators, and entry/exit of all enclosed shafts. These a ling of penetrations shall be the responsibility of the Contractor.

Where each duct passes through a wall, floor or ceiling, there shall be a clear annular space of 20mm between the duct and structure. After all of the duct work is installed the Contractor shall check the clearance, pack the voids full depth with glass/mineral fibre,and caulk both ends with a non-ageing, non-hardening seal ant backed by a polyethylenefoam rod or permanently flexible fires top material. Where there is not sufficient accessspace to

pack around all sides of a duct (e.g., at the underside of a slab), first place a shortstub duct in the wall, pack and caulk around it and then attach the inlet and outlet ductsto each end.

Where ducts enter or leave a shaft or pass through a wall or slab insufficient numbers and density that individual pack-and-caulk details are not possible, a special isolation detail shall be developed.
Before the shaft is fully enclosed the penetration shall be sealed with a heavy membrane surrounding the ducts on each side of the wall or slab being penetrated. Each membrane maybe 2 layers of plaster board, 25mm plaster or 14gaugelead sheet. Other materials maybe acceptable. The void between the two membranes shall be packed with mineral fibre or pumped full of resilient closed cell fire stop foam. All edges shall be caulked air tight. (This detail shall be assigned to the Contractor unless otherwise specified. In all cases the proposed details shall be approved by the Engineer.

HVAC, Domestic Water, Sewer and Vent Piping:
Where a pipe passes through a sound-sensitive wall, ceiling or floor slab, a steel sleeve shall be castor grouted into the structure. The internal diameter of the sleeve shall be 40mm larger than the external diameter of the pipe passing through it.
After all of the piping is installed in a specific area, the Contractor shall check the clearance and correct it, if necessary, to within 12mm. Then the void shall be packed full depth with glass/mineral fiber and sealed at both ends, 20mm deep, with sealant backed by foam rod.

Where pipes pass through a masonry wall insufficient numbers and density that individual pack-and-caulk details are not possible, a special isolation detail shall be developed.

Cast the pipe sleeves in a block of concrete with the sleeves located at least 50mm apart and then build the sleeved block into the wall. The block shall be at least as thick as the surrounding wall construction. Each sleeve shall have a diameter 40mm larger than the external diameter of the pipe passing through it. After the pipes are installed, the voids shall be packed and caulked as described above.

Compressed Air and Sprinkler Piping:
Fire protection and compressed air pipes maybe sleeved and sealed as described above, or may be grouted and caulked into the structure as follows:
Before grout has set, rake a groove around the pipe on each side of the wall or slab. The groove shall be 12mm wide and 12mm deep. After grout has set, fill the groove full depth with sealant.
Penetration of sound isolating ceilings (concrete or multi-layer plaster board) by sprinkler pipes and heads shall be sleeved and sealed as described herein. There shall be no rigid connection between ceilings and pipes or heads.

## 1.04 ACOUSTIC COMMISSIONING

If required by the Contract, noise and vibration commissioning shall be undertaken by the Main Contractor and MEP Sub-Contractor to confirm compliance with the specified acoustics, noise and vibration criteria.
Method statements shall be prepared as necessary, for the following site measurements to be completed the type and number of noise and vibration measurements and tests to be completed shall bediscussed and agreed with all interested parties.
The Contractor shall be responsible for payment of tests and inspections (inclusive of retests

and re-inspections) required because of failures and shall be responsible for all remedial works required to meet the specified acoustics, noise and vibration criteria.

**END OF SECTION**

**SECTION 11**
**LIFT SPECIFICATIONS**

# LIFT SPECIFICATIONS

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and Volume 1 Specification Sections, apply to this Section.
B. Specification Sections in Particular to note:
a. 01 23 01 Schedule of Approved Manufacturers Suppliers and Subcontractors.

### 1.2 SUMMARY

A. This Section includes the following:
1. The complete provision and installation of the 1 no. lift.
2. It includes all engineering, labor, and permits necessary for the proper completion of the work under the Contract.
B. This is a generic specification, to allow the Contractor to go to any of the three approved manufacturers for a solution. Should the Contractor's proposed Lift Supplier prefer a difference in specification, hoistway, overhead or pit size this must be notified at tender stage.

### 1.3 REFERENCE STANDARDS

A. Lift shall be furnished and installed by the Contractor as specified herein, using the best recognized practices and construction where an appropriate British Standard/Code of Practice is current at the date of tender. The Contractor is required to ensure that all goods or materials used of supplied and all workmanship shall be in accordance with that Standard or as described in this document whenever is the higher.

### 1.4 QUALITY ASSURANCE

A. Equipment to be installed by a company approved by the manufacturers and with at least 5 years' experience in similar installations.
B. Deliver, store and handle materials in accordance with manufacturer's instructions.
C. The contractor, by commencing the work of this section, assumes overall responsibility to assure that all assemblies, components and parts shown or required within the work of this section comply with contract documents and are compatible with each other and with the conditions and expected use. Drawings and general provisions of the Contract, including General and Particular Conditions and Volume II Specification Sections, apply to this Section.

### 1.5 SUBMITTALS

A. Shop drawings at 1:20 scale showing the equipment installed with sufficient information on levels, setting-out and full co-ordination with associated services and finishes. Show and identify all necessary builders work in connection.
B. Name of Manufacturer selected from approved list along with name and prequalification's of manufacturer's approved installer if applicable.

**1.6 PROJECT CONDITIONS**

A. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during and after installation.

B. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

C. Protect adjacent surfaces during the progress of work in this section.

**1.7 DELIVERY, STORAGE & HANDLING**

A. Deliver and store packaged materials in manufacturer's original unopened containers with seals unbroken and labels intact until time of use. Promptly remove from site any components which show evidence of damage, and immediately make all replacements necessary.

**PART 2 - PRODUCTS**

Should the Contractor's proposed lift manufacturer prefer a difference in specification, hoist way size exceeding that shown on the drawings this should be immediately notified to the Engineer for review.

| **Elevator Specification** | |
|---|---|
| **Elevator Designation** | **Details** |
| Quantity | As per drawing |
| Manufacturing compliance | EN 81-1 |
| Machine Room | Available |
| Capacity | 1350 |
| No. of passenger | 15 |
| Speed | 2 |
| Main power supply voltage | 400 volts |
| Voltage Fluctuation | 10% |
| Main frequency | 50 HZ |
| Light power supply | 230 volts |
| Hoist way width | As per specification |
| Hoist way depth | As per specification |
| Headroom height | As per drawing |
| Well pit height | As per drawing |
| Machine room height | As per drawing |

| | |
|---|---|
| Number of stops | 14 |
| Access sides | 2 |
| Travel height | As per drawing |
| Car ceiling | Flush integrated lighting with 2.3 m height |
| Car floor | Artificial Granite |
| Car front and side wall | Stainless steel hairlines finish |
| Car front rear walls | Stainless steel hairlines finish |
| Car finish | Stainless steel hairlines finish |
| Car door | Stainless steel hairlines finish |
| Door sill | Aluminium |
| Control system | VVVF drive |
| Electrical Control system | Full collective control |
| CCTV camera cabling | Cat 6 |
| JAMBS | Wide and Tilted |
| Scope of works | Supply, Installation, testing & commissioning, 1-year free maintenance. |
| Warranty | 5 years |
| Protection Pad for Service Lift | yes |
| Ventilation | |

**DOOR SAFETY:**

Multi-beam door sensor System consists of a transmitter detector, a receiver detector and a controller. Multi infrared-light beams or a light curtain is achieved by infra-red-light beams travelling directly between the transmitter and receiver detectors which cover the full width of the door as it opens or closes to detect Passengers or objects. The system not only increases passenger safety between the doors but also reduces damage to the lift doors.

**HALL INDICATORS:**

Type PIV1-A910N, Vertical combined unit comprising of 7 segment LED position indicator, directional arrows and round type stainless steel tactile buttons which self-illuminate with yellow orange colour LED response light on registration of calls in at all floors. Hairline stainless steel face plate in plastic case.

**SPECIAL FEATURES**

1. Safe landing (SFL)

If a car has stopped between floors due to some equipment malfunction, the controller checks the cause, and if it is considered safe to move the car, the car will move to the nearest floor at low speed and the doors will open.

2. Power-on releveling (PORL)
If a car stops in the door zone due to power failure, the car will relevel to secure the floor level after the power is restored, and the doors open.
3. 1-side brake back up operation (BTUP)
When either one of the brakes breaks down, the car goes to the nearest available floor automatically at slow speed while the other brake is applied, in order to rescue the passengers.
4. Detection of high temperature in heat-sink of inverter (THMF)
The car stops at the nearest floor in order to protect the inverter when the surface temperature of the cooling fin exceeds 80 degrees centigrade predetermined value.
5. Firefighter's emergency operation (FE) –
In case of a fire, when the firefighter's switch is activated, the car calls of a specified car and all hall calls are canceled and the car immediately returns to a predetermined floor. The car then responds only to car calls which facilitate firefighting and rescue operations.
6. Fire emergency return (FER)
Upon activation of a key switch or a building's fire sensor, all calls are canceled, all cars immediately return to a specified evacuation floor and the doors open to ensure safe passenger evacuation.
7. Emergency landing device (ELD)
Upon power failure, a car equipped with this function automatically moves and stops at the nearest floor using a rechargeable battery, and the doors open to ensure passenger safety.
8. Car call canceling (CCC)
When a car has responded to the final car call in one direction, the system regards remaining calls in the other direction as mistakes and clears them from the memory.
9. Car fan shut off- automatic (CFO-A) and Car light shut off- automatic (CLO-A)
Car ventilation fan and lighting shut off automatically to conserve energy if there are no calls for a specified period.
10. False call canceling (FCC-P)
If the wrong car button is pressed, it can be canceled by quickly pressing the same button again twice.
11. Independent service (IND)
The car is excluded from normal operation and hall calls cannot be registered for independent use, such as maintenance or repair, and responds only to car calls. The activation of IND is turning on/off by pressing the floor button of the car's current position and the door open and close button on the car operating panel simultaneously for 3 seconds.
12. Next landing (NXL)
If the elevator doors do not open fully at a destination floor, the doors close and the car automatically moves to the next or nearest floor where the doors will open.
13. Overload holding stop (OLH)
A beep, as well as voice guidance, sounds to alert passengers that the car is overloaded: the doors remain open and the car does not leave that floor until enough passengers exit the car.
14. Door load detector (DLD)
When excessive door load has been detected while opening or closing, the doors immediately reverse.

15. Door nudging feature (NDG)
A beep, as well as voice guidance, sounds and the doors slowly close when they have remained open for longer than the preset period.
16. Repeated door-close (RDC)
Should an obstacle prevent the doors from closing, the doors will repeatedly open and close until the obstacle is removed.
17. Reopen with hall button (ROHB)
Closing doors can be reopened by pressing the hall button corresponding to the traveling direction of the car.
18. Inter-communication system (ITP)
A system which allows communication between passengers inside a car and the building personnel.
19. Emergency bell (EMB)
A system for entrapped passengers in a car to contact a person outside by pressing the alarm button on the car operating panel.
20. Door open/close buttons:
Door open/close buttons are provided on the car operating panel to expedite the door opening function or to keep the doors open until the door open button is pressed or to expedite the door closing operation after the passengers have alighted from the car.
21. Other features:
BUFFERS Urethane type
SAFETY Gradual type
GUIDE RAILS Steel Tee sections for cabin & formed sections for counterweight.
POWER SUPPLY 400 V 3Phase 50Hz.
LIGHTING SUPPLY 230 V 1Phase 50Hz.

**PART 3 – EXECUTION**

The work will be carried out concurrently with the work of the Building Contract and the Main Contractor will be required to carry out certain work in connection with the Specialist Subcontract.

**BUILDER'S WORK AND ATTENDANCE**
The main contractor is to allow for all builders work as per requirements of the Elevator Subcontractor
listed elsewhere in connection with the elevator installation.
The Main Contractor shall also provide normal attendance including all usual facilities for the execution of the Specialist Sub-contract.

**AS-FITTED DRAWINGS AND SERVICE MANUALS**
On completion of the elevator installation and at least one week prior to the date of inspection, the contractor shall hand over to the Engineer as-fitted elevator installation drawings. Two sets of instruction manuals for general running and maintenance and repair are to be provided.

**GENERAL**
The Contractor shall commence the electrical installation from the circuit breakers provided

for this purpose. All the works shall be coordinated with the other Contractors prior to installation, so that there will be no areas of incompatibility.
The elevator system shall be equipped with traction machinery and associated traction equipment, elevator cars, solid state control systems and all other equipment and accessories required to provide a complete, modern, durable and efficient vertical transport system.
All the electrical equipment shall be compatible with the available electrical system of the villa, as specified under Electrical Section.
All the components shall be selected to provide satisfactory operation under prevailing environmental conditions at site.
The contractor shall be responsible for the complete maintenance of the elevator for a period of 12 months from the date of acceptance by the Engineer of the complete elevator installation and shall include for cleaning, oiling and inspection of the elevator and all the associated equipment at periods of one month and to include for all emergency calls throughout the 24 hours of the day through the failure of the elevator to operate normally.
A monthly inspection sheet shall be submitted to the Engineer immediately after each monthly inspection and cleaning and greasing.
The Contractor shall also give notice that any fault notified will receive immediate attention on the day of the notification.

**CAPACITY**
Elevator shall have a safe carrying load inclusive of weight of complete car cable and ropes and in accordance with the schedule above.

**SPEED**
The rated speed of the elevators shall be as specified in the schedule above.

**MACHINE**
The elevator shall be equipped with variable voltage and variable frequency controlled geared motors, having stepless, smooth speed time characteristics.
The machine shall be designed to meet the severe service condition encountered in the elevator operation.
Traction sheave, hoisting motor, electromagnetic holding brakes etc. shall be mounted on a heavy steel bed plate. The steel bed frame shall be mounted on a suitable vibration damper to isolate the machine from the structure of the villa.
All rotating parts shall be statically and dynamically balanced to ensure smooth running. All the rotating electrical machinery shall be fitted with microtherms, to provide overload protection.
The winding insulation levels of the motors shall be of Insulation Class `b'.

**MOTOR DRIVE**
The variable voltage, variable frequency motor drive [VVVF] unit will control the motor speed using a microprocessor.
The VVVF system will be provided with a converter which performs AC-to-DC conversion and an inverter which is designed to invert DC to three-phase variable voltage variable frequency AC. The inverter will give an output of sinusoidal current with zero [0] through fifty [50] hertz by application of pulse width modulation technology.
The inverter will control voltage and frequency continuously and accurately in accordance

with speed command signal which is performed by a microprocessor in the elevator controller.
The VVVF drive unit will be capable of keeping the elevator service under the following condition:
Supply line voltage fluctuation: - 10% to +5% from the rated voltage.
Frequency variation: - + 2% from the rated frequency
The VVVF drive unit will be provided with contactors for removing the power from the motor of the traction machine. The contactors will open each time the car stops. The brake of the traction machine will be applied while the contacts drop out.
A pulse rotary encoder will detect the actual speed of the car. The difference between the speed command signal and the actual speed measured by the pulse rotary encoder will control the motor speed while the car is accelerating, decelerating and landing.
Protective devices will ensure to open the main circuit between the VVVF unit and the motor of the traction machine to stop the elevator when one of the following conditions occurs: Phase reversal, phase failure, failure of supply voltage, overcurrent, overheating of thyristor and transistor, operation of any safety device.

**CONTROL SYSTEM**
The control system will consist of the VVVF motor drive unit and a computerized controller. A computer controlled regulator will control the car speed by comparing the actual car speed detected by a pulse-rotary encoder with an ideal speed pattern generated by a microprocessor.
While the car is accelerating, an ideal accelerating pattern will be generated by the microprocessor to obtain the smooth and optimum acceleration.
While the car is decelerating, the microprocessor will calculate and provide the ideal speed pattern to obtain the comfortable and stable riding performance.
At landing, a smooth landing pattern will be generated by a microprocessor, and as soon as the car has stopped, the mechanical brake will be applied to hold the car.

**OPERATION:**
1. As described in the Schedule above.
HOISTWAY EQUIPMENT
A) GUIDE RAILS
For smooth running of the counterweight and the elevator car, guide rails with steel tee sections shall be installed, covering the entire height of the elevator shaft. The rails shall rest on the hoistway pit to prevent exerting any physical forces on hoistway ceiling or walls of the villa.
Proper expansion joints shall be provided to withstand forces created on temperature variations.
B) HOISTING ROPES
Bright steel wire ropes with fibre cores of adequate cross-section manufactured or steel wire ropes with adequate cross-section, manufactured.
C) GOVERNOR ROPES
These shall be manufactured similar to hoisting ropes. The two ends shall be securely linked to the car and attached to the safety gear operating level. The governor ropes shall be tensioned by a weight-loaded device located in the pit.
D) COUNTERWEIGHT
Cast iron blocks enclosed in a steel framework shall be provided to balance the

weight of the car and the specified capacity.

E) BUFFERS

Oil type buffers shall be fitted in the hoistway pit beneath both car and the counterweight. These shall be securely mounted on continuous RS channels and correctly disposed relative to the car and the counterweight.
The plunger shall be of mild steel, accurately machined and designed to provide very high safety factor. A toughened rubber bumper shall be fitted to the top of the plunger to withstand the impact of the steel buffer plates mounted on the underside of the car and the counterweight. An oil gauge shall be provided to check the oil level.

**TRAVELLING CABLES**

The travelling cables shall be 450V/750V grade multi-core with stranded high conductivity copper conductors, especially designed for elevator duty. These cables shall be properly supported by retaining straps and individual cable clamps.
CAT 6 for camera cabling.

**SAFETY EQUIPMENT**

The gradual type safety system, comprising of a close loop roping system, over-speed centrifugal governor, safety gear equipment etc. shall be provided.
The operation of the system shall be such that if the car overspeed's in the downward direction, the governor jaws shall trip, operating the safety gear. It shall, in sequence, cut off the motor power supply, apply normal brakes and engage the safety gear gibs when the safety gear gibs engage with the car guides. It shall apply a constant retarding force to bring the car to a gradual and smooth stop within defined limits.

Re-setting of the safety devices shall be possible by moving the car in upward direction.

a) Over Travel

Over travel limit switches shall be provided at the top and bottom of the terminal landings to disconnect the power supply and apply brakes to bring the car to safe stop position in the event of an over travel in either direction.

b) Evacuation Devices

Provision shall be made to move the car manually from the machine room to a nearest landing in either direction to facilitate evacuation of passengers during a power failure.

c) Fireman Emergency Operation

Fire Emergency Operation Button enclosed in a breaking glass shall be installed near the entrance on the main landing and shall operate any one of the elevators under conditions of emergency, in the event of fire.
When the Fireman Emergency Call Button is pressed, it shall immediately disconnect the elevator under normal automatic operation and the car shall return to the main landing. It shall not register any hall calls, so that the passengers will not wait for the elevator. The car shall then only operate on the attendant operation and it shall start registering the hall calls.

**ELEVATOR CAR**

The size of the car, interior design and decorations, ceiling and lighting and other facilities shall be as per arch. Requirements or approval.

The car shall be of rigid steel framework with sound isolation designed and manufactured all in accordance with relevant Sections.
The operating buttons and keys shall be as given in the relevant Section of the Specification. The following facilities shall be provided for each car, in addition to the items already specified.

a) Ventilation
Electric Ventilator mounted on car roof with proper vents to be provided.
b) Emergency Lighting
Self-contained, non-maintained emergency light, with a trickle charger.
c) Emergency Exit
An Emergency Exit shall be provided on car roof. This door shall be able to open either inside or outside. A safety electrical switch shall be provided to prevent the car travelling when this emergency exit is open.
d) Intercommunication System
Intercommunication system shall be provided between the car and staff areas.
e) Working Platform
A working platform shall be provided on the roof of the car.
f) Car and Landing Doors
The car and landing doors shall be fully automatic, two panel, automatic sliding doors. The type and finish of the doors shall be as specified in the Schedule.
g) Door Operator
The door operator shall be high speed heavy duty, with a VVVF controlled AC Motor. The inverter shall include high speed switching device which inturn shall provide a smooth sine curve of output current to assure smooth, quite and precise door control. The opening and closing speeds of the doors shall be adjustable. The landing and car doors shall operate in full synchronism. Advance door opening during car's approach to a landing could be used to speed up user transfer.
h) Safety Features
Emergency unlocking key from landing side for evacuation and maintenance work.
Manual opening of the doors from inside the car, within landing zones during power failure.
Full door height safety-edge device in the leading edge of the car doors to reverse the doors when there is any obstruction for closing.
Electrical interlock to operate in conjunction with the car doors, so that elevator cannot operate unless doors are closed.
Overload indicator with buzzer. If the car is overloaded it shall prevent from starting. The blinking overload indicator and the sounding buzzer shall signal the overload condition to the passengers.
Emergency light with trickle charger.

**TESTING**

On completion, a thorough test of the elevators under the working conditions shall be carried out in the presence of of the Engineer.
All materials used must be of the highest quality and the best of their respective kinds and must comply with the relevant Codes. All weights necessary to carry out the full load and overload tests must be provided by the Contractor and removed after use.

The tests will include the following:
No load current and voltage readings both on `Up` and `Down` Circuits.
Full load current and voltage readings both on `Up` and `Down` Circuits.
One and quarter load current and voltage readings both on `Up` and `Down` Circuits.
Stalling current and voltage and time taken to operate overload.
Overload protection.
Gate sequence relays, if provided and installed.
All interlocks.
Collective control and priority sequences, if installed.
Safety gear mechanism.
Speeds on Up and Down travel with loadings and empty.
Door contacts.
Final terminal stopping device.
Normal terminal stopping device.
Insulation and earth continuity.

**OPERATING PANELS AND INDICATORS**

a) Car Operating Panel
The car operating panel of each elevator shall contain the following:
Operating buttons numbered to correspond to the landing served with acknowledge light for each button.
Emergency call button.
Door Open and Door Close Buttons.
Intercom Station.
Overload indicating lamp with buzzer.
b) Landing Position Indicator
Car position indicator shall be provided for the car, in the car and over the landing entrance of the elevator. As the elevator travels through the hoistway, its position shall be indicated by the illumination of the numeral/letter corresponding to the landing at which the elevator is stopped or passing. Indicators shall be properly designed for better recognition with colour filters to provide good contrast. Travel direction indicators shall also be included in this indicator.
c) Push Buttons and Indicator for Landing
1) Up and Down call buttons with indicator lights to show that the call has been registered.
2) Hall Indicators/Call Buttons to be provided as specified in the schedule.
3) Fire Alarm call button in a break-glass fixture at the main landing.

**CAR AND LANDING SILLS**

Sills manufactured as specified in the schedules shall be fitted at every landing entrance and on the car platform for the entire width of the door opening.
These sills shall be with integral grooves to act as guide for the bottom of the door panels.
The car sill shall be securely fitted to the car platform and the landing sills securely fitted to the entrance threshold. These sills shall be flushed with the finished floor level.
The sills shall be designed to provide adequate strength to support the loads excerting on them, in addition to the safety and decorative entrance plate appearance.

ELECTRICAL INSTALLATION

General wiring throughout the installation shall be carried out as specified in the Electrical Specifications. GI trunking shall be used wherever possible instead of multiple conduits. GI conduits and flexible conduits shall be used between trunking and apparatus.

Earthing of all the equipment's shall be carried out as specified in Electrical specification and as per IEE Regulations.

Distribution Equipment shall contain all protection equipment for motors and circuits. These shall include

**Defects Liability Period**

At least 15 days prior to expiration of Defects Liability Period, schedule final inspection and retest with the FM team. Requirement shall include close examination of all equipment.
Replace, repair or adjust any equipment found defective.

Maintenance Period
Provide 12 months Maintenance following TOC.
Replace, repair or adjust any equipment found

**END OF SECTION**

# SECTION 12
# SWIMMING POOL PLUMBING SYSTEMS

# SWIMMING POOL PLUMBING SYSTEMS

## PART 1 - GENERAL

Drawings and general provisions of the Contract, including General and Particular Conditions and Volume II Specification Sections, apply to this Section.

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Volume 1 Specification Sections, apply to this Section.
B. Related Sections include the following:
Schedule of Approved Manufacturers, Suppliers & Subcontractors.

### 1.2 SUMMARY

A. This Section includes the supply and fix of swimming pools filtration equipment with associated accessories. It includes the process of installing the items listed. The Contractor to design & execute the work listed in coordination with swimming pools specialist. The swimming pools are as shown in the drawings.

B. The intent of this tender document is to provide the Contractor with design guidelines, criteria, specifications, standards, and procedures, up on which the full detailed calculated design, material submittals & shop working drawing must be prepared and submitted for the supply, installation, testing, commissioning, start-up and warranty of a completely and perfectly workable and operational pools & water features system.

C. The Contractor shall embrace and include every expense necessary to complete the whole of the works, including the design and provision for which all plant and ancillary equipment shall comply with these requirements.

D. The scope as given hereunder this section is the absolute base minimum requirement, the general form and nature to be complemented with the supply of additional equipment so as to complete the installation in accordance to the best possible international standard and to the satisfaction of the owner/engineer.

E. The Contractor should specifically note that the supply of equipment and installation are to be completed in all respect as specified in the contract drawing and specification. Any additional equipment and works that may be involved or required to complete the installation as required shall be supplied, installed and commissioned without any additional cost or delay to the contract.

F. Work-covered by these specifications shall include Design, furnishing labor, materials, equipment and services required for the complete installation, testing and commissioning, operation and maintenance and aftercare of pools & water features Systems in accordance with the drawings and the specification. The work shall not be limited only to the drawings listed but to all other affiliated drawings required for the installation of any mechanical and electrical systems. Detailed shop drawings & hydraulic calculations shall be submitted for Engineers approval.

G. The Contractor is responsible for the design of all items shown in the scope of works to enable completion of the works and shall provide all necessary Detail Drawings, Coordinated Installation drawings and Builder's work Drawings/Information, and will employ a specialist Sub-Contractor from the approved list for this purpose.

H. Scope Includes:
1. Design, manufacture, supply, delivery and off-loading into installation area of the specified equipment, including duties and taxes.
2. Co-ordination of the works with all interfacing contractors, suppliers and manufacturers.
3. Installation of all the equipment.
4. Testing, commissioning and demonstration (including staff training) of the specified equipment.

**1.3 THE CONTRACTOR'S OBLIGATIONS IN MORE DETAIL**

The Contractor shall employ the Specialist Sub-Contractor for the following:
The Contractor shall be responsible for the preparation of all drawings and information as described hereinafter, based on the drawings issued by the Engineer. All drawings shall be prepared on A1 size for construction and post-construction purposes but shall generally, be presented at A3 size for review by the Engineer.

The workshop drawings shall clearly show all dimensions, details, specifications, connections or joints to other trades, incorporation of the work of other trades, etc. all to be approved by the Engineer before commencement of work.
These drawings shall also specify all necessary Builders' Work in connection with movement precautions, sound and thermal protection etc.

The Contractor shall furnish to the Engineer for approval drawings and schedules showing details of Builder's Work required in connection with the Works in their Sub-Contracts. The Builder's Work Drawings shall be prepared in such order and at such times as to enable them to be checked and approved and subsequently issued so as to avoid any delays to the programme for the Works.

The Specialist Contractor shall employ a competent person experienced in the coordination of the above-mentioned drawings to perform this duty to attend necessary coordination meetings.

The Contractor shall check and verify all site measurements wherever requested to enable them to prepare their own shop drawings, and pass on the information with sufficient promptness as will not in any way delays the Works. A copy of all such information passed on shall be given to the Engineer.

Should the Engineer instruct the alteration of amending of any drawing prepared by any of the parties stated above then the Contractor shall ensure that this is done immediately in order to avoid any delay to the construction programme and no claim for extra payment or extension of time for completion of the Works shall be allowed for any reason in this respect.

The Contractor shall prepare a detailed programme for the production of the drawings and information required immediately upon receipt of the Engineer's order to commence the Works. The programme, which will be subject to the scrutiny of the Engineer who may alter or amend it as he sees fit, shall be compatible with the programme for the construction works.

The Contractor shall prepare and submit to the Engineer a schedule of material submittals/procurement/delivery details, which highlights the long lead items. During the progress of the works the schedules shall be maintained by the Specialist Sub-Contractor to the approval of the Engineer.

Two copies of each material submittal shall be provided to the Engineer including one original copy of manufacturer's literature. The Contractor shall allow the Engineer two weeks for the review of all submittals.

All plant and equipment submittals shall include a list of manufacturers recommended spare parts and special tools to be provided under the Contract.
The Contractor shall make all calculations necessary for providing an installation capable of meeting the Performance Specification. Such calculations shall be submitted for approval.

The Contractor shall be solely responsible for the whole of the design works and shall carry out all necessary studies and surveys, produce all drawings, schedules and all other documentation necessary, and provide adequate supervision to ensure the proper design, construction and maintenance or the works within the approved program.
The drawings and specifications prepared by the Consultant show layouts, levels and sections that indicate the schematic design scheme based on consultations with the client.

The Contractor shall base his detailed design on the drawings and specifications being aware that the Contractor becomes solely responsible for this conceptual design.
No alternative to the specified design criteria or specifications shall be allowed and be considered acceptable, and any proposal deviating from the design criteria's and materials specifications shall not be acceptable and will be rejected automatically

The scope of design works shall include but not be limited to the stages described below:
1. Preparation of all necessary drawings showing layouts, levels, plans, sections and elevations based upon consultation with and approval of the Engineer.
2. Preparation of proposals for service connections based on discussions with the responsible Engineer.
3. Preparation of proposals for supply and distribution of mechanical, electrical, water and other systems.
4. Preparation of drawings showing interfaces, modifications to and extensions of existing works.

Provision of Operating, Training and Maintenance Instruction Manuals: The Contractor

shall allow for supplying, on the handover date, four copies of manual containing full details of all equipment supplied under this Contract. Each manual shall include the following information:
1. Detailed schedules of all equipment.
2. Manufacturer's name, address and telephone number.
3. Part /Serial and Order numbers, and any other relevant information.
4. Full operation instructions.
5. Full maintenance instructions.
6. Spare Parts List.
7. Wiring diagrams and test certificates, where applicable.
All information should be indexed and cross referenced, for ease of use. One copy of the manuals shall be submitted to the Engineer for approval, prior to the handover date.

USE OF THE INSTALLATION BY THE CONTRACTOR: The Contractor shall be allowed to use the installation for testing and commissioning only when the following requirements have been fulfilled:
The Contractor has received written permission from the Engineer to use the installation.
The Contractor has given seven working day's written advice of the date of commissioning, etc., to the Engineer.
The Contractor has arranged for a qualified and competent engineer to be in attendance on the plant and installation during the period of operation.
All costs and charges arising from the four items listed above shall be borne by the Contractor.

SPARES: Three weeks prior to Taking Over, the Contractor shall prepare and submit to the Engineer, for his approval, a priced schedule of recommended spares in respect of all works installed by him.
This shall be divided into two categories:
1. Recommended essential spares for a period of two years.
2. Recommended secondary spares for a period of two years.

TESTING & COMMISSIONING SUMMARY: Include for all necessary testing on completion to confirm that works meet operating performance.
Once the equipment under this contract has been erected, positioned and connected to services, it is the Contractor's responsibility to fully test and commission both the equipment and services connections.
The object of this testing is for the Contractor to satisfy himself, and the Engineer that the equipment is:
1. Free from all manufacturing defects, including leaks, blockages, component failures, etc.
2. Connected to all necessary services, and that these services are adequate to provide the equipment with the required power, water, waste and ventilation under full capacity working conditions.
3. Completely safe to operate.
Any specially fabricated equipment shall be tested and certificated before it leaves the manufacturer's works, but should also be re-tested on site.
The Contractor shall give the Engineer seven days' written notice of his intention to carry out any test, and shall have carried out all necessary adjustments prior to commencing

such test.

TRAINING: The Contractor shall allow, within the quoted prices, for attendance by qualified personnel employed by them and/or their suppliers, to carry out training of Employer's Filtration maintenance Staff on all items of equipment supplied within the Contract. The demonstrations shall be recorded on an order by the Contract and a copy of the tape(s) left with the Operators.

**PART 2 – GENERAL**

**2.1 FILTERS FOR SWIMMINIG POOLS**

A. Type: Permanent media, pressure.
B. Function: Turbidity removal, to 5 microns filtration fineness in continuous recirculation application.
C. Construction: Fiberglass shell, threaded inlet and outlet pipes, CPVC distribution and collection pipes with laterals, access hand hole with synthetic gasket and external locking bar, pressure relief valve, integral supports and lifting lugs.
D. Face Piping: pipe designed for maximum 10 fps (3.05 m/s) velocity of water at rated filter capacity, incorporating line size butterfly valves. Furnish sight glass at waste connection.
E. Valves: Hydraulically operated diaphragm type with PVC body and socket ends.
F. Controls: Electrically operated (240 v / 1 ph. / 50 Hz) semi-automatic controller (mounted on the filter body) to perform backwash, rinse and reversion to service; once initiated manually.
G. Accessories: Air bleed valve, pressure gauge manifold, auxiliary cartridge filter for control supply etc.

**2.2 PUMP FOR SWIMMING POOL**

A. Type: Horizontal, end suction, close coupled, single stage centrifugal type of 1500 rpm speed. Materials of construction shall be as follows:
Casing …… Corrosion Resistant Composite Material
Impeller ……. Noryl
Shaft …… Stainless steel
Seal Mechanical
B. Pump motor construction shall IP55 TEFC.
C. Accessories: Compound gauge at suction and pressure gauge at discharge, flexible connections at suction and discharge, basket strainer at suction.

**2.3 SAND FILTERS**

D. Assembly: pressure sand-and-gravel type consisting of filter tank(s), face piping with butterfly valves, and gage panel.
E. Construction: Fiberglass shell, threaded inlet and outlet pipes, CPVC distribution and collection pipes with laterals, access hand hole with synthetic gasket and external locking bar, pressure relief valve, integral supports and lifting lugs.
F. Influent Distribution System: Schedule 40 PVC pipe consisting of head and laterals with orifices directed upwards, designed for maximum 10 velocity of water in laterals at rated filter capacity.
G. Under-drain System: Schedule 40 PVC pipe, consisting of header and laterals with

orifices pointed downwards, designed for maximum 10 fps (3.05 m/s) velocity of water in laterals at rated filter capacity. Space laterals and orifices to allow uniform water flow through filter bed during filter and backwash operations.
H. Face Piping: PVC pipe designed for maximum 10 fps (3.05 m/s) velocity of water at rated filter capacity, incorporating line size butterfly valves. Furnish sight glass at waste connection.
I. 1" automatic air relief valve shall be provided to automatically and continuously release air in the filter. The valve shall be fabricated of plastic. A plumbing kit shall be provided with two (2) PVC ball valves to allow manual air relief and isolation of the automatic valve.
J. Automatic operation
1. Main Operating Valves: The main operating valves shall be a nest of individual diaphragm valves. A Hydraulically operated dedicated pilot valve shall control the opening and closing of the valves. The valves shall be slow opening and closing, and free of water hammer.
2. Flow Control: An automatic backwash control shall be provided to maintain a proper backwash and fast flush flows over wide variations of operating pressure. This shall ensure proper flow rate during the operating cycle in order to prevent loss of filter media during backwash and to save water during the conditioning rinse cycle.
3. Controls: The filter shall be equipped with electronic stager to program the backwash cycle of the filter at any time of day.

**2.4 VALVES**
General
1. Provide valves from the same manufacturer throughout where possible.

GATE VALVES
1. Up to 50 mm (2 inch) nom. size: PVC body, non-rising stem and union bonnet, solid PP wedge, socket ends.
2. Over 50 mm (2 inch) nom. size: PVC body, non-rising stem and union bonnet, solid PP wedge, flanged ends, EPDM seal.

Globe Valves
1. Up to 50 mm (2 inch) nom. size: PVC body, rising stem, union bonnet, renewable composition PP disc, PP plug, socket ends, EPDM seal.
2. Over 50 mm (2 inch) nom. size: PVC body, PVC stem, PP plug, flanged ends, EPDM seal.

Ball Valves
1. Up to 50 mm (2 inch) nom. size: CPVC body, CPVC ball, EPDM seat seals and stuffing box ring, lever operated, socket ends.

Check Valves
1. Up to 50 mm (2 inch) nom. size: CPVC, in-line, resilient seat and disc, spring loaded, EPDM seal, socket ends.
2. Over 50 mm (2 inch) nom. size: CPVC body, CPVC trim, spring loaded, renewable composite CPVC disc and seat, EPDM seal, flanged ends.
3. Over 50 mm (2 inch) nom. size: CPVC body, CPVC trim, swing type with external

lever and weight, renewable CPVC seat and disc, EPDM seal, flanged ends.

Drain Valves
1. CPVC angle globe pattern, key operated, socket inlet and hose connection outlet with cap and chain.
J. Pressure Ratings
1. Unless otherwise indicated all valves shall be rated for 1034 Kpa (150 psig) working water pressure at 121 deg.C (250 deg.F)
2. Contractor shall allow for selecting higher pressure rated valves to meet the valve construction features.

Valve Operators
1. Provide hand wheels / operating levers for valves as appropriate. Hand wheels for gate and globe valves 50 mm (2 inch) nom. size and smaller, shall be non-ferrous metal (die cast zinc / aluminium alloy etc.).
2. Provide one key / wrench of appropriate size per lever operated valve installed.
3. Provide chain operated sheaves for valves located more than 2 Ms (7 feet) above floor. Extend chains to about 150 cm (5 feet) above floor and hook to clips in order to clear walk ways and equipment.
4. Provide geared operators for valves 200 mm (8 inch) nom. and larger in size.

TRIPLE DUTY VALVE
IBBM combined globe and check valve with calibration stops, specially made for use at the discharge of centrifugal pumps.

QUADRUPLE DUTY VALVE
IBBM, combined globe and check valve with calibration
stops and flow measurement ports with cocks and hose adaptor, specially made for use at the discharge of centrifugal pumps. Furnish one flow measuring instrument for the project.

AUTOMATIC AIR RELEASE VALVE
Bronze body with non-ferrous float and internal
working parts. Construction shall be take-apart type for easy maintenance. Outlet shall be tapped for connection to drain.

AUTOMATIC FLOW CONTROL VALVES
Bronze body with stainless steel cartridges.
The valve shall be factory set to the required capacity and shall operate within + or - 5 % over an operating pressure differential of at least 14 times the minimum required for control. Valve body shall be rated for minimum 1034 Kpa (150 psig) wwp and shall have threaded/flanged ends. Each valve shall be furnished with a set of nipples, quick disconnect valves and other fittings suitable for use with the measuring instrument specified.

FLOW MEASURING INSTRUMENT
Pressure gauge with -100 to 1034 Kpa (-14.7 to
150 psig) range, dual 150 cm (5 feet) long connection hoses with vent and shut off

valves, flow conversion charts and carrying case.

**2.5 FLASHING AND SEALING**

Provide sheet lead (minimum 3 mm thick) flashing of minimum (3 feet) diameter at all drains and flashing sleeves in the fountains.
Use age proof, water compatible, poly sulphide sealant at the joint of nozzles' stand pipes with the flashing sleeve.

**2.6 MOTOR CONTROL CENTER AND OTHER ELECTRICAL COMPONENTS.**

Electric Motors
1. All motors shall be manufactured to BS EN 60034, wound for the system power supply ratings and suitable for continuous operation in the ambient conditions stated and designed to work for a period of at least five (5) minutes at 75 % of the system power supply voltage without abnormal overheating and damage.
2. All motors shall be squirrel cage induction type, with TEFC enclosure unless otherwise stated on particular schedules or dictated by selection. The ends of the windings shall reach a terminal box; fitted with a junction box, cable inlet and adaptor plate with adjustment (cable pincers etc.); adequately sized to suit the type of cable used and arrangement shall be such that an easy permutation of two phases is possible without upsetting the connections. Tapping for cable entry shall be made to suit the site requirements
3. Motors shall have foundations, bolts and sliding rails where required.
4. All motors shall have a minimum power factor of 0.85 from 75 % to full load.
5. All motors shall have windings with class 'B' temperature rise and class 'F' insulation. Provide anti-condensation heaters in stator windings for all motors.
6. Winding bridges, where used shall be tinned copper of adequate size and supplied by the manufacturer.
7. Motor name plates of etched aluminum shall state:
a) Name of manufacturer.
b) Serial no. and frame size.
c) Power, speed and power factor.
d) Electrical supply.
e) Type of starting.

**2.7 AUTOMATIC PH/CHLORINE DOSING, MONITORING & CONTROLLING SYSTEM.**

A. Digital Chemical Controller
1. Quantity/performance: As per drawings.
2. Application: In order to sense the chlorine & pH the pool water and control the chemical dosing pumps.
3. Automatic chemical dosing controller comprises of two channel controllers with large clear graphical display for measured variables, full text user guidance, limit value monitoring with adjustable automatic cut out as standard, disturbance free 2 wire probe connector, 2 electrically isolated 0/4-20 mA signal outputs, wall mounted type, IP65 Protection, Power connection shall be 220/240V, 50/60Hz, measuring range pH and Chlorine c/w sensors, sensor cables and in line probe

housing.

B. Chemical Dosing Pumps
1. Quantity/performance: As per drawings.
2. Application: In order to maintain pool water pH neutral, yet maintaining marginal residual chlorine level in pool water.
3. Chemical Dosing Pumps: Base mount or wall mount type, Pumps following. IP 65 Protections. Power connection shall be 220/240V, 50/60Hz. The materials in contact with the liquid shall be PVDF pump head, Ceramic ball valve, PVC EDPM seat valve and PTFE diaphragm. Unit shall include for anti-acid plastic case. Operating panel protection provided by a transparent polycarbonate cover. Manual regulation. Continuous stroke length adjustment from 0-100%, External control via volt-free contacts, Connector for dual-setting level switch, 3 LED display for operation, warning and fault indication.

C. Chemicals Tanks:
1. Quantity/performance: As per drawings.
2. Application: To house disinfectant with water with minimum capacity of 1 week.
3. Chemical dosing tanks: Tanks made of UV-Stabilized polyethylene with screw cap integral sintered threaded bushes for the assembly of metering pumps.
4. Each tank to be supplied with an electric stirrer.

**2.8 CHEMICAL FREE PHYSICAL DISINFECTION UV- IONIZATION SYSTEMS**

1. Quantity/performance: As per drawings.
2. Application: In order to reduce the risk of high dosing of chemical which impact negatively on the bather and environment, the chemical free UV Ionization system will reduce this risk. (With chlorine level 0.4 -0.5ppm)
3. The chemical free physical disinfection shall be packaged system pre-piped, prewired consisting of the following.
4. Ultraviolet sterilizer:
a. Electro-polished reactor in stainless steel 316L
b. Dosage of minimum 60mJ/cm2
c. 150 psi working pressure
d. Lamp life time: 9000 hours.
e. UV lamp failure pilot
5. Metal ionizer electronically operated that emits 30% silver ions and 70% copper ions, complete with electronic controlled unit and monitor, ionization cell and copper/ silver electrodes.

**2.9 RECIRCULATING FITTINGS**

A. Main Drain Fittings - Anti-Entrapment
1. Quantity: As per drawings.
2. Material of construction: 316 stainless steel
3. Dimension /flow rate:
a. 20 inch x 20 inch
b. 24 inch x 24 inch

c. 28 inch x 28 inch
d. 34 inch x 34 inch
e. 44 inch x 44 inch
4. Plate thickness: 12 gauge
5. All drain fittings used in swimming pools must have safety anti-entrapment drain covers, Pool and Spa Safety Act (max. velocity 0.45 m/s).
6. ASME A112.19.8-2007 Compliant
7. No anti-vortex drains will be accepted.

B. Overflow/Gutter Drain Fittings
1. Quantity: As per drawings.
2. Type: Fittings and Grate
3. Material of construction: 316 stainless steel
4. Flow rate: 40gpm
5. Connection: 2 inch

C. Adjustable Return Inlet Fittings
1. Quantity: As per drawings.
2. Type: Flow adjustable type.
3. Material of construction: 316 stainless steel.
4. Connection: 2 inch
5. Flow rate: 14 $m^3$/hr

D. Vacuum Fitting / Plug Drains
1. Quantity: As per drawings.
2. Material of covering: Stainless steel
3. Connection: 2 inch female (Plug with O-ring seal)

E. Water Level Sensor / Controller
1. To protect pump and underwater lights from dry running protection
2. To give a signal to main water supply solenoid valve to fill and top-up automatically water, when water level is down (maintain constant water level)
3. Level Sensor
a. Quantity: As per equipment schedule
b. Body material: Brass.
c. Cover: 316 stainless steel
d. Air vents: 1 No.
e. Water entry: 2 Nos.
f. Electrodes: 3 Nos. 316 stainless steel
4. Level Controller
a. Quantity: As per equipment schedule
b. Function: Automatic liquid level regulator;
c. Operation: Selectable pump up or pump down;
d. Type: Complete static detection;
e. Sensitivity adjustment: 4.7 to 100 K ohm;
f. LED Indicator light: Supply and relay.
F. Ladders & Hand Rail
1. Quantity: As per drawings

2. Number of steps: As per equipment schedule
3. Material of contract: Stainless steel 316
4. Accessories: Rails & non-slip steps and anchoring
5. Fixing

**2.10 Heat Cool Pump**

1. Heat Cool Pumps shall be as shown on the drawings and shall be of compact design for outdoor and indoor installations with internal thermal, acoustic insulations and high-pressure fan. They shall be provided with condensate collecting tray as per manufacturer's standards. Condenser shall be air cooled type with high efficiency, scroll sealed compressor and R134a refrigerant. Compressor shall be acoustically insulated by way of external cover. Fan shall be direct motor coupled type. Units shall be provided with titanium heat exchanger with titanium tubing for corrosion and wear resistance for longer life and value.
2. The units shall be provided with safety and protection items such as bipolar thermal overload switch in the operating circuit, high- and low-pressure switches with manual setting, overall ground connection, compressor and ventilator thermal protection relays in three phase units, internal thermal protection in compressor and ventilators, anti-rattle timer in single phase equipment and evaporation battery protection grating as minimum requirements.
3. The units shall be suitable for 400V/3PH/50HZ power supply. Control panel shall include digital electronic thermostat to control pool water circulation pump and units, defrosting thermostat, water inlet and outlet thermometers indicators.
4. The heat cool pumps shall be installed outdoors with a 1m clearance all around, and 2m clearance above each unit.
5. All heat cool pumps shall be installed in a open air well ventilated area or in a well ventilated area with mechanical ventilation as per the required flow rate. The exhaust of the heat cool pump shall be ducted to outside.

**2.11 GRP BALANCING TANK**

Manufacturer's Qualifications: Firms regularly engaged in manufacture of specified items with characteristics, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years in the United Arab Emirates.

1. The tanks shall be manufactured by Hot Press Moulded method to the quality standard requirements of BS EN ISO 9001: 2008 and shall comply with BS 6920:2000.
2. The panels shall be manufactured from sheet moulding compound (SMC) using hot press moulded method at high temperatures up 150°C using unsaturated polyester resins and glass fiber.
3. The unsaturated polyester resins shall have equal quality to "Class UP-G" which are determined by JIS R 6919 and good quality in weather and water resistance. The glass fiber used in the panel shall be non-alkaline quality which is determined by JIS R 3412 and JIS R 3413.

4. The panels should have ivory color, which has a lower heat absorption factor than darker color. The panel shall have high opaque quality to prevent evaporation of sterilizer and the growth of algae. Another panel color will not be accepted.
5. Panel Specifications:
Specific Gravity >1.8g/cm
Tensile Strength >100Mpa
Flexural Strength >150Mpa
Flexural Modulus >11,500Mpa
Impact Strength 82.8kg/cm/cm2
Shore Hardness Barcol > 45
Shear Strength 934kg/cm2
Glass Content > 31.5%
Thermal Expansion 3 x 10-5°C
Thermal Conductivity 0.03kcal/(m.k)
Overall Heat Transmission 0.2kcal/mhr°C
Coefficient of Water Absorption <0.1%
Light Transmission <0.1%
6. All tanks shall be provided with an inlet, outlet, overflow, drain, air vent fittings & electrode base fittings (all in PVC).
7. Acrylic tube water level indicator shall be provided.
8. Fiberglass reinforced plastic manhole 600 mm diameters, hinged with a lockable cover to prevent rain water and dust to enter the tank.
9. All tanks deeper than 1m shall be fitted with internal ladder of PVC, external ladder of hot dipped galvanized steel
10. All tanks up to 3m should be externally braced with hot dip galvanized steel sections as per JIS H 8641. No internal bracing will be accepted for tanks up to 3m. Tanks 3.5m & 4m shall be internally braced by stainless steel 316 tie rods.
11. Tanks to be completely sealed with flexible, food grade, special synthetic rubber and butyl.
12. Insulated tanks should be of sandwich type double skin fully insulated by rigid polystyrene foam of average thickness 25 mm depending on the panel profile and covered with ABS UV resistant cover of 1 mm thickness.
13. Metallic Components and Accessories:
a. Bolts, nuts and washers used for the assembly of the tank shall be stainless steel 316.
b. Bolts & nuts used for flanges shall be resin covered stainless steel.
c. The metallic parts installed inside the tank above water level shall be of nylon coated steel.
d. A nonmetallic tubes (UPVC) or nylon coated steel tubes can be used for roof supporting.
14. Bottom panels should have convex shape to drain off completely and to withstand the pressure of the stored water. At least one concave specially designed drain panel should be included in each tank or tank compartment. Roof panels designed with 1/100 slope to avoid stagnant water.
15. Where partitions are required, they will be full height using standard panels. Each compartment will be capable of supporting water on either side with one side empty.

16. All tanks to be installed on a foundation of reinforced concrete beams. The concrete foundation should be of rigid construction, permanent in nature made up of durable weather resistant materials. The foundation shall be flat, smooth, and free from any irregularities and with properly leveled surface to nearest ± 2 mm. The height of the concrete beams must be at least 50 cm above the finished floor level. To allow for installation and maintenance of tanks in the future, the free space around the concrete foundations to be 50 cm for tanks up to 2 meter high and 1 meter for tanks above 2 meter high. The concrete foundation plan should be provided by the tank supplier.
17. The tank shall be fixed on an galvanized steel footing as per the recommendation of the tank manufacturer.
18. The Contractor will guarantee all material and workmanship for at least 10 years after preliminary take over.
H. Installation:
1. All tanks shall be installed strictly in compliance with the manufacturer's instructions.
2. All cisterns to be installed on either flat continuous foundation or close center beams conforming to manufacturer's specification of flatness and deflection.
3. Installation shall be carried out by approved installers.
4. All tank openings shall be done on site, as per requirements.
5. Testing shall be carried out on completion of installation and to be completed within ten working days of assembly.

**2.12 Control Panel & Starters**

Main pool shall have its own control panel.
Include for a wall mounted control panel. This shall incorporate mains isolator, interlocked with the door handle, hinged access doors, indicator lamps, internal wiring and spare sets of fuses, terminals and relays. The starters for all pumps shall be provided within the control panel.
Construction of panels shall comply with the relevant clauses of the electrical specification.
It should control pumps, filters, chemical treatment, underwater lights, all necessary instrumentation and control.

**2.13 POOLS MAINTENANCE KIT & AUTOMATIC POOL CLEANERS**

A. Pools Maintenance Kit: The items below shall be specially manufactured to be used for swimming pool.
1. Vacuum head: Include a flexible body with encapsulated wheels with extra long nozzle for 1.5' vacuum hose
2. Anodized aluminum telescopic handle: The grip-lock mechanism enables easy adjustment of the pole length and the comfortable hand grip vacuum head size to 8 – 16" (2.44 – 4.88mm)
3. Vacuum hose: The floating vacuum hose should be suitable for all climates. The vacuum hose should be 25 m long
4. Pool brush: Four rows of superior nylon bristle on a tough shaped polypropylene stock

5. Leaf net: Durable frame and integral pine mesh net to remove floating debris
6. Algae brush: High-quality stainless-steel bristles with a swivel head suitable to clean walls and floors
7. Pool test kit: Test kit checking PH and chlorine levels with chemicals up to the final handing over
8. Leaf rake: Durable frame and integral mesh net and scoop to clean the bottom of the pool
9. Professional 25 test phonometer kit.

B. Automatic Pool Cleaner

1. The purpose of the pool vacuum cleaner is to be used periodically to clean pool floors specially those areas where stagnant non-re-circulated water movement is not possible
2. Turbo action swivel design and regulator valve for more vacuuming & cleaning.
3. Large intake for even better leaf and debris vacuuming
4. Regulator valve automatically adjusts water flow to control cleaners speed
5. Unique dive float assembly for improved balance and wall climbing ability
6. Hard wearing flapper with life time guarantee
7. Patented head design improves water flow to the pool pump
8. Beaded bumper roller assembly helps move machine off steps
9. Adaptable suction seal works with wide coverage on all pool surfaces
10. Universal neoprene footpad works on all pool surfaces

**PART 3 – GENERAL**

3.1 INSTALLATION GUIDELINES

The contractor shall be responsible for the supply of materials falling within the scope of this contract, the protection, unloading and storage on site of all such materials.
The contractor shall be responsible for the supply of labor, tooling and all materials necessary for the proper installation all haulage equipment and support structures necessary.
The contractor shall inform the architect, in writing any omission, lack of coherence or any other error in the contract tender documents. Failure to do so shall indicate that the contractor fully understands and acknowledges all aspects of the tender documents.
The contractor shall be responsible for the installation of all mechanical and electrical components in the plant rooms including water feature animation, pumps, manual and automatic valves, pipe work, anti-vibration sleeves, .
Adjust water systems for volume and water flow characteristics to reflect design intend and as directed by the Engineer.

4.1 POST-INSTALLATION AND AFTERCARE

Upon completion of installation the specialist subcontractor shall ensure that the Pools/Water features are all in perfect working order for the preliminary handover.
Upon satisfactory initial handover the specialist sub-contractor shall provide the services to supervise and instruct the client's staff on the operation and maintenance of the Pools/Water Features.
The specialist sub-contractors shall be responsible for the on-call maintenance of the Pools/Water features systems for a twelve (12) months period after the initial handover of the works. Costs of all such maintenance are to be borne by The Contractor and are

included in this contract.

The specialist sub-contractors shall submit to the Engineer two sets of the draft operation and maintenance manuals for approval at preliminary handover and shall include but not confined to the following:

a. Description of Pumps, Filters, Disinfection, Control and etc…

b. Control and wiring diagrams

c. Installation, operation, lubrication and maintenance information

d. Valve schedule detailing valve duty type location and number

e. Schematic system flow and control diagrams identifying the location and function of all system components, valves and controls.

Three (3) sets of the approved, fully book bound, manuals shall be submitted to the Engineer at handover.

The specialist sub-contractors shall provide as-built drawing of the Pools/Water features including drawings showing the electrical installation and manufacturer's details of plant installed.

The specialist sub-contractor shall supply three (3) sets of as-built drawings within four weeks of the commissioning of each Pools/Water features and with six complete sets of approved drawings submitted within four weeks of handover.

**END OF SECTION**

**SECTION 13**
**PEX PIPES**

# PEX PIPES

## PART 1 - GENERAL

Cold and hot water distribution pipework embedded within builder's work inside toilets, bathrooms, kitchen shall be composed of:

- Cross linked polyethylene pipe according to DIN 16892 and 16893 pulled in a corrugated conduit of ordinary polyethylene.

- Fittings and valves of DZR brass construction.

- Pipes and fittings must be certified by WRAS and WVGD laboratories.

### 1.1 PIPES

A. The inner pipe shall be a cross link polyethylene pipe withstanding upto 95 deg. C at a max. pressure of 10 bar without deformation or damage. Short time temperature loading up to 110-degree C.

B. The pipe shall be resistant to all-natural constituents of drinking water to DIN 2000, disinfectants and cleaning agents to DVWG – W291 and DIN 2000, anti-corrosion agents to DIN 1988 T4 (E) and common building materials, such as mortar, cement and plaster.

C. The pipe and fittings manufacturer shall offer minimum of 50 years guarantee for the pipes and 10 years guarantee for the complete system from TOC (taking over certificate).

D. All pipes and fittings shall be stamped on equal intervals showing clearly the name of the manufacturers along with the pressure and temperature rating of these pipes.

E. All pipes shall be laid so that the 16mm per water pipe can be replaced, if necessary.

#### 1.1.1 Fittings & Accessories

A. Pipes shall be connected to the different fittings via a wall box of reinforced plastic fitted with DZR brass elbow suitable for 15mm or 20mm threaded connection. The box should be suitably designed in order to enable the replacement of existing pipes in the event of their damage.

B. All valves, box elbows, tees, bends shall be of DZR brass. Contractor shall use proper tools for assembly as recommended by manufacturer, i.e. assembly pliers, Ratchet torque wrench, cutters, etc.

### 1.2 EXECUTION

#### 1.2.1 PREPARATION:

1.2.2 Ream pipe and tube ends. Remove burrs.

1.2.3 Remove scale and dirt, on inside and outside, before assembly.

1.2.4 Prepare piping connections to equipment with flanges or unions.

### 1.3 INSTALLATION

1.3.1 Route piping in orderly manner and maintain gradient.

1.3.2 Install piping in a way that conserves building space and does not interfere with the use of space.

1.3.3 Group piping whenever practical at common elevations.

1.3.4 Install piping to allow for expansion and contraction without stressing pipe joints or connected equipment.

1.3.5 Install exposed piping parallel or at right angles to the building walls, except where otherwise shown on the Contract Drawings.

1.3.6 Where changes in pipe sizes occur, install tapered reducer fittings. Use of bushings is not permitted. Install eccentric reducer fittings with level crown.

1.3.7 Where changes in pipe direction occur install factory manufactured fittings. Bending or forming of piping is not permitted without Engineer's written permission.

1.3.8 Provide adequate clearance for installation of insulation and access to valves and fittings.

1.3.9 Provide minimum clearances between piping covered by this Section and other services.

1.3.10 Provide access doors where valves and fittings are not exposed. Coordinate size and location of access doors.

1.3.11 Slope water piping and arrange to drain at system low points.

1.3.12 Establish elevations of buried piping outside the building to ensure not less than 9 0 cm (3 ft) of cover.

1.3.13 Where pipe support members are welded to structural building framing, scrape, brush clean and apply one coat of zinc rich primer to welding.

1.3.14 Use main sized saddle branch connections or directly connecting profiled branches (weld lets) to mains in steel piping if main is two pipe sizes larger than branch. Do not project branch pipes inside the main pipe.

1.3.15 Establish invert elevations; slope drainage pipes to one percent minimum unless otherwise stated. Maintain gradients as shown on the contract drawings.

1.3.16 Install test-tees in soil, waste, vent and rainwater pipe risers at minimum 450 mm (18 inch) above the ground floor level, at every alternate level and at other locations as shown on the contract drawings.

1.3.17 During progress of work keep the ends of all piping closed with factory manufactured plugs or blind flanges to prevent entry of foreign matter. Ensure the removal of such plugs or flanges on completion of the works. All blind flanges shall have integral indicating flags.

1.3.18 Install bell and spigot pipe with bell end upstream.

1.3.19 Install valves with stems upright or horizontal, not inverted, except with written permission of the Engineer for each location.

1.3.20 All valves shall be same size as pipeline except if otherwise noted on the contract drawings.

1.3.21 Provide flanges / unions on above grade horizontal pressure piping at spacing not exceeding 18.0 Ms (60 feet) on straight runs so as to enable taking down of the piping easily, when required.

1.3.22 Use valves with flanged ends in valve pits and when directly buried, irrespective of size.

**END OF SECTION**

**SECTION 14**
**MECHANICAL FANS**

## 1.0 GENERAL

### 1.1 Work Included

1.1.1 Compliance with relevant General Requirements of Mechanical Services.

### 1.2 Description of Work

1.2.1 Furnish and install fans as indicated on drawings

1.2.2 Types of centrifugal fans required for project include the following:

a. Axial flow fans

b. Centrifugal Fans

c. Twin fan extract units

d. Smoke extract fans.

1.2.3 Refer to other relevant sections for vibration control units used in conjunction with fans.

1.2.4 Refer to other relevant sections for testing, adjusting, and balancing work required in conjunction with fans.

1.2.5 Refer to relevant electrical sections for the following work:

Power supply wiring from power source to power connection on unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory installed by manufacturer.

Interlock wiring between electrically operated equipment units and between equipment and field installed control devices.

### 1.3 Quality Assurance

1.3.1 Manufacturer's Qualifications: Firms regularly engaged in manufactures of fans of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.3.2 Codes and Standards:

1. Fan to be certified by ASHRAE/AMCA 51-2016 for laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI/AMCA Standard 210-16) (ANSI/ASHRAE Approved).
2. Fans shall be performance tested in accordance with BS 848.
3. Smoke extract and lift & staircase pressurization fans, shall be two-hour fire rated and 400 Deg.C and approved by DCD
4. Motors shall comply with BS 5000.

5. Impellers shall be dynamically balanced to ISO 1940 Grade 6.3.
6. AMCA Compliance: Provide centrifugal fans bearing the AMCA Certified ratings sea. Sound rate centrifugal fans in accordance with AMCA 300 “Test Code for Sound rating air moving devices”.
7. Vibration isolator and deflection shall be selected according to ASHRAE Application handbook chapter 48 table 47.
8. UL Compliance: Provide fan electrical components which have been listed and labeled by UL.
9. Fan motor shall be certified by NEMA and shall comply with BS 5000.
10. Contractor shall provide a detailed external static pressure calculation along with the respective isometrics for approval, during the fans selection and prior to place any order.
11. When selecting the fan, assure that exit air velocity at the fan does not exceed 15 m/s
12. Fan shall be selected such that the duty point on the fan curve falls within 30% of the best efficiency area of the curve.
13. Fan casings shall be constructed of mild steel plates with angle stiffeners, with the casing hot dip galvanized after manufacture. The inlets and outlets of the axial flow fans shall be flanged for connection to the system. A drain plug shall be fitted and the casing designed to permit removal of the impeller.
14. Impeller shall be dynamically balanced to ISO 1940 grade 6.3
15. Blade angle shall be adjustable over at least a 30-degree range, with markings at the root to indicate the blade angle

## 1.4 Submittals

1.4.1 Product Data : Submit manufacturer’s technical product data for fans including specifications, capacity ratings, fan performance, curves with operating point clearly indicated, gages and finishes of materials, and installation instruction.

1.4.2 Shop Drawings : Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.

1.4.3 Wiring Diagrams : Submit manufacturer’s electrical requirements for power supply wiring to fans. Submit manufacturer’s ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory – installed and portions to be field- installed.

1.4.4 Pressure Calculations

Submit pressure drop calculations based on shop drawings for approval by the Consultant before final selection of the unit.

### 1.5 Maintenance Data

Submit maintenance data parts list for each type of fan accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual.

### 1.6 Product Delivery, Storage and Handling

1.6.1 Deliver fans with factory installed shipping skids and lifting lugs, pack components in factory fabricated protective containers.

1.6.2 Handle fans carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air handling unit manufacturer.

1.6.3 Store fans in clean dry place and protect from weather and construction traffic.

1.6.4 Comply with manufacturer's rigging and installation instructions for unloading fans and moving them to final location.

### 1.7 Warranty

Provide five-year manufacturer warranty for the fans.

## 2.0 PRODUCT

2.1 Centrifugal Fans– General.

2.1.1 Furnish, install and connect up complete, all supply, return, exhaust, transfer and exhaust fans. All fans shall be of the non-overloading centrifugal type.

2.1.2 Fans shall have direction of rotation, discharge direction indicated on the casing. Fan arrangement shall be selected to suit the space conditions.

2.1.3 Fan housing shall be rigidly built and braced. Where fan scroll is 480 mm or more in width, provide access door with frame and gasket. All access doors shall be so fabricated that the inner surface is flush with the inside of the scroll. Raised frame doors of the pan type shall be provided on all fans where insulation is required. The doors shall be secured to the frame by hand-grip latches and shall be provided with lift handles. Bolted doors are not acceptable,

2.1.4 Fans shall not produce excessive noise as compared to units of like size and power when used in conjunction with the specified vibration isolation. Fan manufacturers shall furnish for approval for each fan, certified sound power ratings with an octave band analysis and also the volume-horsepower-pressure characteristic curves from shut-off to free delivery. Wheels shall have ample strength and shall be statically

and dynamically balanced to avoid vibration and shall have blades designed to ensure quiet efficient operation.

2.1.5 Fans, unless otherwise indicated, shall be belted to respective motors by "V" belt drives. Sheaves shall be cast steel. Drives requiring 2 grooves or more shall have variable pitch motor sheaves and companion type fan sheaves. Belts shall have a rated

capacity of not less than 150% of the motor horsepower. All "V" belt drives for integral horsepower motors shall have not less than two belts and shall have sufficient belt capacity to drive fans with one belt broken. Sheave ratio shall be selected so that top fan speed is not less than 105% and not more than 110% of rated speed. Drives for fractional horsepower motors may have one belt rated at 200% of motor horsepower. If to balance an air system, a fan other than the one provided should be required, necessary changes shall be made in the "V" belt drive by the Contractor at his expense. Supply and install belt guards of perforated metal, or as approved, for all sheaves and belts. Belt guards shall be grommetted at fan and motor shafts for ease in taking tachometer readings.

2.1.6 Each fan motor shall be sized to drive it's respective fan when fan is operating at a speed (due to pulley adjustment) of 10% in excess of that required to meet fan performance, and when the fan requires the maximum power at this speed.

2.1.7 All fans shall carry the AMCA, or similar approved Certification Association performance and construction seal.

2.1.8 All fans shall be factory coated with one coat of primer and one coat of machine enamel. The interior of all fans and all wheels shall be painted as per manufacturer's standard.

2.1.9 All fans discharging directly up through the roof shall be equipped with a 38 mm casing drain which shall be piped to the nearest floor drain.

2.1.10 All fans scheduled to be arranged as belted vent sets shall have overhung wheels and motors mounted on a common base with the bearings. All such belted vent sets shall be furnished with weatherproof motor housings where located outdoors.

2.1.11 All double width, double inlet fans shall be provided with galvanized steel inlet guard screens. All fans should be provided with

## 2.2 Fans, Axial – General.

2.2.1 Axial flow fans shall be capable of giving the design flow when tested to B.S. 848.

2.2.2 Each fan shall be supplied with a suitably rated contactor/ starter/ isolator of approved pattern.

2.2.3 Fan casings shall be constructed of mild steel plates with angle stiffeners, with the casing hot dip galvanized after manufacture. The inlets and outlets of the axial flow fans shall be flanged for connection to the system. A drain plug shall be fitted and the casing designed to permit removal of the impeller.

2.2.4 An access door is to be provided on the casings of all fans. Casings shall cover both impeller and motor so that fans can be removed without disturbing adjacent ductwork or other components of the system. A flameproof external terminal box shall be fitted on the casing.

2.2.5 All lubrication points are to be extended to the outside of the casing and in a position that will permit access in relation to the adjacent plant, services or building structure.

2.2.6 Impellers shall be die cast in Aluminium alloy and X-rayed during manufacture. The impellers shall be capable of running continuously at 20% in excess of the rated speed. The impeller shall be keyed and locked onto the shaft, which shall be statically and dynamically balanced and tested at over speed before dispatch from the Manufacturer's works.

2.2.7 Flexible connections shall be supplied and installed at both inlet and outlet of each fan.

2.2.8 The fan bearings shall be of the sleeve type wherever possible. The bearings are to be truly aligned and rigidly mounted on to the casing.

2.2.9 Graphs of the performance curve of each fan are to be forwarded to the Consultant together with a test report on the sound level at three diameters in a free field condition prior to the order being confirmed.

2.2.10 Blade angle shall be adjustable over at least a 30 degree range, with markings at the root to indicate the blade angle.

2.2.11 Axial flow fans are to be driven by electric motors of commercially silent pattern carrying a Makers guarantee in this respect. The motors shall be totally enclosed, fan cooled.

2.2.12 All motors are to be positioned to permit effective ventilation of the motor and all component parts of the fan and motor are to be suitable to withstand the temperature conditions expected in the fan.

2.2.13 Electrical connections to the motors shall be in a totally enclosed terminal box secured to the exterior of the casing. Wiring within the axial flow fans shall be suitable for the conditions within the casings.

2.2.14 A suitable steel support is to be provided for each fan, and the frame is to be fabricated from rolled steel channel with adequate cross members for bolting the fan into position. The frame shall be of welded construction with anti-vibration mountings.

2.2.15 The anti-vibration mountings are to be rubber in shear pattern and of a type that are bolted to both the fan and the support.

2.2.16 All fans should be provided with lifting eyes, speed control, non- return dampen and wire guards.

## 2.3 Kitchen Extract Fans

Centrifugal exhaust fans shall be belt driven fans with non-overloading, backwardly inclined wheels with high pressure capability.

Fans shall be single inlet, single width, with clockwise rotation. Fan housing shall be heavy gauge galvanized steel for maximum corrosion protection, with Weld-Lock construction. Housings shall be field rotatable to any of eight 45 deg. incremental air discharge positions.

Fan scrolls shall be equipped with a bolted, gasketed access door for Cleaning and inspection. The bearing supports shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings, bearings shall be heavy

duty self-aligning pillow block ball bearings, grease lubricated and selected for minimum life (L50) of 200,000 hours at maximum operating speed.

Shafts shall be turned, ground, polished and rust protected. Shafts shall be sized so the first critical speed is at least 20% over the maximum operating speed. Close tolerances shall be maintained along the length of the shaft.

The fan wheel shall be non-overloading backward inclined type. The wheels shall be statically and dynamically balanced. The wheel and inlet shall be aerodynamically designed and constructed to provide maximum performance and efficiency.

Pulleys shall be adjustable cast iron, machined keyed and securely attached. Belts and pulleys shall be sized for 165% of the installed motor horsepower.

Motors shall be heavy duty ball bearing, totally enclosed. After assembly the entire unit, with drive train installed and set to specified RPM, shall have a computerized vibration analysis performed. Vibration shall be measured in the horizontal, vertical and axial directions at each bearing to assure quality and smooth operation. The computerized print out shall be filed and made available to

Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal.

Fan air performance ratings shall be bear on test conducted in an AMCA registered laboratory for AMCA 210 air performance testing. The test standard used shall be ANSI/AMCA Standard 210-85, ANSI/ASHRAE Standard 51-1985 "Laboratory Methods of Testing Fans for Rating".

All sizes must be tested calculations to other sizes not acceptable. Fan sound performance shall be based on tests concluded in an AMCA registered laboratory for AMCA 300 Sound Performance Testing. The test standard 300 "Reverberant Room Method for Sound Testing of Fans". All sizes must be tested, calculations to other sizes are not acceptable, Air or Sound tests results are to be made available to owner.

Accessories shall include the following:

a) Ventilated weather cover

b) Drain connection.

c) Vibration isolators.

d) Extended lube line.

e) Access door

f) Gravity damper.

Motors shall be high efficiency, totally enclosed with Class 'F' insulation.

Kitchen fan shall be provided with grease aluminum trap, designed to collect the grease residue.

## 2.4 Smoke Extract Fan

2.4.1 In General; Construction of fan shall comply with the standard axial fan requirement in clause 2.2

2.4.2 Description: Units are designed to permit operation at extreme temperatures for a known time period under smoke operation. Fans to be capable of withstanding temperatures of up to 400°C generally for up to 2 hour duration. Roof units shall include a cowl of fire resistant material.

2.4.3 Motor: Motors shall be foot mounted totally enclosed metric type to IP55, with sealed for life bearings, standard industrial paint finish and Class H insulation to BS 4999 Part 20, IEC 34/1, suitable for operating at high temperatures, motors are to be wired using high temperature rated weatherproofed cable to an IP55 protected terminal box mounted on the outside of the unit casing.

2.4.4 Units are to be designed and manufactured with procedures as defined in BSEN ISO 9001: 1994. EEC Directives shall be met. Motor shall be tested for high temperature operation in accordance with BS 7346 (Part 2) and PR EN 12101-3.

2.4.5 Performance: Fan unit is tested to either National or European draft standards. Smoke extract axial fans shall be tested to ISO 5801 (1997) - Airside Performance, and BS 848 Part 2 (1985) - Sound level performance.

2.4.6 Accessories: Fans shall be complete with the following accessories:

a) Mounting feet

b) Anti Vibration mounts

c) Matching Flanges

d) Inlet Cones

e) Non Return Dampers and Wire Guards

f) Lifting eye

2.4.7 All smoke fans shall be approved by the National Civil defence authority.

## 2.5 Makeup & Pressurization Units

2.5.1 In General; Construction of fan shall comply with the standard axial fan requirement in clause 2.2.

2.5.2 Description: Units are designed to permit operation at extreme temperatures for a known time period under smoke operation. Fans to be capable of withstanding temperatures of up to 400°C generally for up to 2 hour duration. Roof units shall include a cowl of fire resistant material.

2.5.3 Blowers shall be efficient, double inlet, forward curved design in strong, die formed steel housings. Variable pitch pulley shall allow adjustment in RPM for more precise regulation of air flow. Motor, belts, pulley and other components shall form a dependable, durable and quiet operating assembly easily balanced to meet system requirements.

2.5.4 Pressurization fans should be provided with speed control as specified in the schedule.

2.5.5 Housing shall be of epoxy coated, reinforced or galvanized steel.

2.5.6 The housings louvred sides shall permit a direct air path, giving the housing a low profile to the roof. Cleanable, permanent filters back up each louvred side to prevent airborne contaminants from entering. Filters shall be easily removed for cleaning.

2.5.7 Fans shall be complete with smoke sensor and low leakage motorized damper to fully close when smoke exists at the air intake location.

2.5.8 Motors shall be totally enclosed with class 'F' insulation. Fan units shall be UL certified or approved by the local authority.

## 2.6 Car Park Ventilation Fans

2.6.1 Car park areas shall be ventilated using 3 speed ducted Axial flow fan.

2.6.2 In General; Construction of fan shall comply with the standard axial fan requirement in clause 2.2

2.6.3 The ventilation system shall be designed to provide 3 air changes in the normal ventilation mode, 6 air change when CO consitration reach 50 ppm or more,and 10 air changes in the event of fire. in order to clear and dilute smoke across the floor. All fans and main extract fans shall be rated for 400ºC / 2 hour, with the extract flow rate divided between at least 2 fans.

2.6.4 Contractor to submit a detailed sequence of operation for Engineers review and approval.

2.6.5 Electrical connections to the motors shall be in a totally enclosed terminal box secured to the exterior of the casing. Wiring within the axial flow fans shall be suitable for the conditions within the casings.

2.6.6 A suitable steel support is to be provided for each fan, and the frame is to be fabricated from rolled steel channel with adequate cross members for bolting the fan into position. The frame shall be of welded construction with anti-vibration mountings.

2.6.7 The anti-vibration mountings are to be rubber in shear pattern and of a type that are bolted to both the fan and the support.

2.6.8 All fans should be provided with lifting eyes, speed control, non- return dampen and wire guards.

2.6.9 Fans shall have approval by the UAE civil defense authorities.

## 2.7 Carbon Monoxide Detection System

2.7.1 The system to comprise of remote sensors, exact location to be agreed with the Consultant. Sensors to be wired to multiple channel carbon monoxide monitors.

2.7.2 Control shall be 24 volt, 1 ph, 50 or 60 Hz.

2.7.3 Monitor controls to be housed in a lockable NEMA-12 enamel finished cabinet with hinged door and be complete with window.

2.7.4 Cabinets to be fitted with indicating lights to indicate sensor being monitored and level of carbon monoxide.

2.7.5 Carbon monoxide sensors will continuously monitor the concentrations of carbon monoxide (CO) prevailing within the car park.

2.7.6 On sensing 50ppm at any CO sensor, a visual and audible alarm shall be initiated at the panel.

2.7.7 Zone indication of CO sensor being monitored shall be indicated on the multiple channel CO monitor.

2.7.8 The CO monitor shall be interfaced with car park ventilation fans

2.7.9 The CO monitor shall be interfaced with the BMCS.

## 2.8 Fire Fighter's Smoke Control Station (FSCS)

2.8.1 Fire fighter's smoke control station (FSCS) shall be located as indicated on drawings.

The control station shall include the following features:

a) The fire fighter's smoke control station shall provide full monitoring and manual control capability over all smoke control systems and equipment.

b) The control station shall have the highest priority control over all smoke control systems and equipment. Where manual controls are also provided at other building locations for control of smoke control systems, the control mode selected from the FSCS should prevail. FSCS control should override or bypass other building controls such as hand off auto and start/stop switches located on fan motor controllers, and controls intended to protect against electrical overloads, provide for personnel safety, and prevent major system damage.

c) The fire fighters smoke control station shall contain a building diagram that clearly indicates the type and location of all smoke control equipment (fans, dampers, etc.). The building areas affected by the equipment shall also be clearly indicated.

d) The actual status of the systems and equipment that are activated or are capable of activation for smoke control shall be clearly indicated at the fire fighters smoke control station.

e) Status indication shall be provided for on and off status of each individual fan used for smoke control. 'ON' status should be sensed by pressure difference as proof of air flow.

## 2.9 Wall/Window Mounted Extract Fans - Propeller

2.9.1 Extract fans shall be of the propeller type suitable for window or wall mounting.

2.9.2 Front cover shall incorporate a finger guard for improved safety. Removal of front cover shall stop the fan motor and isolate accessible wiring.

2.9.3 Motor shall be lubricated for life and shall be fitted with a thermal cut out providing protection against accidental overloading.

2.9.4 Fans shall include air operated back draught dampers.

## 2.10 AIR CURTAINS

2.10.1 Air curtains shall be suitable for doors of width up to 3m and height up to 2.4m. unit shall be complete with a polycarbonate cabinet of colour acceptable to architect. Units shall operate at very low sound level to prevent disturbing personnel and customers.

2.10.2 Units shall be provided with adjustable louvre damper controls to regulate airflow.

2.10.3 Motor shall be class "F" insulation, totally enclosed, rated for continuous duty with lifetime lubricated sealed ball bearings and protected with thermal overload switch.

## 3.0 EXECUTION

3.1 Installation

3.1.1 Install as shown on the drawings, as detailed, and according to manufacturer's installation instructions. On units provided with a drain connection, reduce drain connection down to ½inch fitting and leave open.

3.1.2 Align fan and motor sheaves to allow belts to run true and straight.

3.1.3 Bolt equipment to curbs with galvanized lag bolts.

3.1.4 Install thrust restraints in accordance with the requirements of the relevant sections:

a) HANGERS AND SUPPORTS

b) MECHANICAL SOUND, VIBRATION & SEISMIC CONTROL

3.1.5 Install SAT according to manufacturer recommendation and acoustic study

3.1.6 Flexible connections shall be supplied and installed at both inlet and outlet of each fan

3.1.7 Electrical connections to the motors shall be in a totally enclosed terminal box secured to the exterior of the casing. Wiring within the axial flow fans shall be suitable for the conditions within the casings.

3.1.8 A suitable steel support is to be provided for each fan, and the frame is to be fabricated from rolled steel channel with adequate cross members for bolting the fan into position. The frame shall be of welded construction with anti-vibration mountings

## 3.2 Pre-Operation Maintenance

3.2.1 Grease bearings.

3.2.2 Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.

## 3.3 Start-Up and Instructions

3.3.1 Check vibration and correct as necessary for air balance work.

After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in relevant section MECHANICAL SOUND, VIBRATION & SEISMIC CONTROL

## 3.4 Testing, Balancing and Commissioning

3.4.1 Testing, Balancing and Commissioning shall be as detailed in manufacturers commissioning literature and in standards listed in this Section as well as per Testing, Adjusting and Balancing sections.

3.4.2 Coincidentally with the above test, all medium and high pressure ductwork systems as defined by SMACNA shall be tested for air leakage.

3.4.3 Provide notice of any test to the Consultant in writing in accordance with Contract requirements so that, where he deems necessary, the Consultant or his representative shall witness the test. The test rig and all necessary blanks for the purpose of sealing the ductwork under test shall be provided, and blanks shall be removed after the test has been approved for each section of the ductwork.

**END OF SECTION**

**SECTION 15**
**CHILLED WATER PIPES**

The Contractor shall supply, install, test chilled water pipe work as detailed in this specification and as indicated on the drawings.
For sizes 2" and below: -
ERW Black steel pipes to ASTM A53, Grade B Sch.40.Plain ends.
For size 21/2"and above: -
ERW Black steel pipes to ASTM A53, Grade B Sch.40 Beveled Ends.

Outdoor Chilled Water pipe

i. All outdoor chilled water pipes shall be thermally insulated by rigid sections of aluminum foil faced glass fibers insulations with density of 64 Kg/m3 for the use between the temperature of 43 F and 150 F having a thermal conductivity of 0.21 BTU IN / FT2 h F at mean temperature 50 F. The insulations shall be fixed on the pipes as recommended by the insulation manufacturers.

ii. The outdoor pipes insulations shall be protected with a water proof 20x20 (thread/inch) woven glass cloth cover painted with two coats of approved fire resistant and anti-fungal lagging adhesive. Additionally, a third coat of approved weather proof adhesives shall be applied over the cloth. Finally, where insulated pipes work run on roof floor, top roof floor, chillers yard, pump room and inside shaft (open to sky) shall be cladded with 24-gauge aluminum sheet. The chilled water pipes insulations throughout the complete risers length inside shaft (open to sky) shall be also aluminum cladded.

| Pipe Size DIA (Inch) | | Minimum Thickness (Inches) |
|---|---|---|
| ½" | - | 1 ½ " |
| ¾" | - | 1 ½ " |
| 1" | - | 1 ½ " |
| 1 ¼" | - | 1 ½ " |
| 1 ½" | - | 1 ½ " |
| 2" to 8" | - | 2 " |

6.2 Indoor Chilled Water pipe

The pipe works shall be thermally insulated with rigid sections of aluminum foil faced glass fibers insulations having density of 64 Kg/m3 and thermal conductivity of 0.21 BTU IN / FT2 h F at mean temperature of 50 F . The insulations shall be fixed on the pipes as recommended by the insulation manufacturer. The pipes shall be insulated by 40 mm thick rigid insulations for pipe sizes up to 40 mm dia and insulated by 50 mm thick rigid insulations for pipe sizes from 50mm dia upto 200mm dia. The pipe insulations shall be protected with a water proof 20x20 (thread/inch) woven glass cloth cover painted with two coats of approved fire resistant, anti-fungal lagging adhesive.

**END OF SECTION**