TECHNICAL SPECIFICATION

FIRE FIGHTING SYSTEM

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1. Pipe and Fittings

1.1 Material – Pipes, Fittings and Sleeves

A. General Requirements:

a. All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultants.
b. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
c. Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.
d. Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.
e. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.
f. Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipe work.
g. All pipe work shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

B. **Underground/Outside pipes** shall be **GI ERW** conforming to IS: 1239 (heavy class) duly wrapped and coated as per IS: 10221. The coating / wrapping protection shall be tested with Applicable Standards

C. **Pipes for risers, Basements, headers and floor branches inside the building** shall be **GI ERW** conforming to IS:1239 heavy class “C" up to 150 mm dia. Pipes 200 mm dia. and above shall conform to IS 3589 with 6 mm thick walls. The Galvanizing shall conform to IS:4736. The Zinc coating shall be uniform, adherent, reasonably smooth and free from imperfections such as flux, ash and drops inclusions, bare patches, black spots, pimples, lumpiness, runs, rust stains, bulky white deposits and blisters.

D. Following pressure rating criteria to be followed while selecting the pipes
   a. System working pressure to be limited to 12 bar unless otherwise specified elsewhere
   b. Pressure breaks to be provided (if required) in the intermediate level or as per schematic drawings.

E. **Pipe/Grooved (Standard/Light wall):** Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with manufactures specified listed standards conforming to ANSI/AWWA C-606.

F. **Pipes fittings** :-

i. For 50mm dia and below shall be of Malleable Cast Iron fittings confirming to IS 1879:2000.
ii. Alternatively, for 50mm dia and below pipe diameter socket welding can be considered subjected to approval from Client/Consultant. Socket welded fittings shall be Forged steel socket welding fittings confirming to IS 4712 and ASME B16.11. and ASTM A105-2017
iii. For 65mm to 150 mm dia. shall be steel tube fittings confirming to IS1239 Part 2 plain end heavy class. Fittings to be selected for working pressure 1.5 times higher than system working pressure. (Fittings PN rating shall be 1.5 times higher than the system working pressure).
iv. Manufacturer’s standard fittings shall be used and fabricated fittings will not be accepted.

G. **Joints in risers/down takes-**

All risers/down takes shall be installed with grooved flexible couplings with necessary fittings. However the Specialist contractor shall submit the detailed calculation based on building sway movement, column shortning, thermal expansion and shall propose the number and location of - flexible joints for Engineer's / Client's approval.

H. **Joints in Horizontal & branch floor piping :-**

i. Screwed/Socket welded (50mmdia pipes and below)

Joint for G.I pipes and fittings shall be made with thread joints and unions. A small amount of red lead may be used for lubrication and prevention. Joints shall not be welded or caulked. Alternatively, for 50mm dia and below pipe diameter socket welding can be considered subjected to approval from Client/Consultant.

ii. Welded/Victaulic (65mmdia and above)

Joints between G.I pipes and G.I fittings shall be made with fitting having "V" groove and welded joints electrical resistance welding in an approved manner. Joints for the buried pipes will be subject to Hydrostatic & Dry Penetration test from an approved agency as per the Fire Insurance norms. (With welded G.I fittings heavy class with "V" groove). Flanged joints with flanges confirming to IS:6392 shall provided where ever required. Grooved Victaulic joints also acceptable subjected to consultant/client approval.

iii. Flanged joints (65 mm dia and above).
All flanges shall conform to IS: 6392-2003 Table 17 as applicable. Flanged joint shall be made with 3 mm thick insertion rubber washer/ gaskets, bolts and nuts conforming to IS: 1367 (Galvanized). Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Employer's Representative. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings. Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.

iv. Unions (up to 50 mm dia):
Approved type of dismountable unions shall be provided on pipe lines of 50 mm dia and smaller dia, in locations similar to those specified for flanges.

I. **Sleeves**

Provide sleeves for each pipe passing through walls, partitions, and floors. Sleeve Materials: Sleeve materials shall be 3mm thick galvanized steel. Sleeves for Un-insulated Piping: Two pipe sizes larger than pipe passing through sleeve or a minimum of 12mm clearance between inside of sleeve and outside of pipe. Adequate clearance shall be provided to install fire stopping material.

J. Sleeve Lengths

Location Sleeve Length : - All floor sleeves to extend minimum of 50mm above finished floor level.
Walls and Partitions : - Equal to depth of construction and terminated flush with finished surfaces.

Sleeves which are contained in walls, ceilings or floors which are fire barriers shall be additionally packed with a non-combustible material for the entire length to form a fire/smoke stop of the required fire rating and sealed with approved fire sealant. The material shall be subject to approval and must comply with Building Control and the Building Regulations. The ends of sleeves packed with material which shall have suitable fire resistant mastic applied to seal the fibers and present a neat appearance.Refer Annexure-1

1.2 Material – Grooved Couplings/Fittings

a. References and Standards
   a. American Society for Testing Materials (ASTM)
      i. ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
      ii. ASTM A-183 – Carbon Steel Track Bolts and Nuts
      iii. ASTM A-234 – Standard Specification For Piping Fittings or Wrought Carbon Steel and Alloy Steel.
      iv. ASTM A-449 – Quenched and Tempered Steel Bolts and Studs
      v. ASTM A-536 – Ductile Iron Castings
      vi. ASTM F-1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications
   b. American Society of Mechanical Engineers
      i. ASME B16.9 – Factory Made Wrought Butt Welded Fittings
      ii. ASME B31.1 – Chemical Plant and Petroleum Refining Piping
      iii. ASME B31.9 – Building Services Piping
   c. American Water Works Association
      iv. AWWA C-606 – Grooved and Shouldered Joints

b. Quality Assurance
   a. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by original manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.
   b. Pipe/Grooved (Standard/Light wall): Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with manufactures specified listed standards conforming to ANSI/AWWA C-606

c. Standard Mechanical Couplings (2 inch through 12 inch):

   Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12.Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard.

   a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
   b. 2” through 6”: “Installation Ready” for direct stab installation without field disassembly.
   c. Flexible Type:-Coupling key shall be designed to fit into the wedge shaped groove and allow for linear and angular movement, vibration attenuation, and stress relief. Support requirements defined in the tender.Coupling or fitting that allows axial displacement, rotation, and at least 1 degree of angular movement of the pipe without inducing harm on the pipe. For pipe diameters of 8 in. and larger, the angular movement shall be permitted to be less than 1 degree but not less than 0.5 degrees.” (NFPA 13-2007 3.5.4)
   d. Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges. For direct connection to ANSI Class 300 flanges use.
   e. Grooved couplings shall meet the requirements of ASTM F-1476.
   f. Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

   Note: - Reference shall always be made to the manufacturers guide for proper gasket selection for the intended service.

d. Mechanical Couplings (14 inch through 24 inch):

   Couplings shall consist of two ASTM A-536 ductile iron housing segments, a wide elastomer pressure responsive gasket, and zinc electroplated carbon steel track head bolts and nuts conforming to the physical and chemical requirements of ASTM A-449 and the physical requirements of ASTM A-183.

a. Coupling housings designed with the wedge-shaped key profile to engage the mating pipe(s)/component(s) wedge-shaped grooves. Housings include lead-in chamfer to accommodate a wider acceptable range of initial pipe positions. Housings shall be coated with orange enamel or galvanized.
b. Gasket: Synthetic rubber, wide width, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

Note: -Reference shall always be made to the manufacturers guide for proper gasket selection for the intended service.

c. Coupling Types:

i. Rigid Coupling: Coupling key shall be designed to fill the wedge shaped groove to provide a rigid joint that corresponds with support spacing's as defined by ASME B31.1 and B31.9. Systems incorporating rigid couplings require the calculated thermal growth/contraction of the piping system to be fully compensated for in the design of the piping system through use of adequate flexible components.
ii. Flexible Coupling: Coupling key shall be designed to fit into the wedge shaped groove and allow for linear and angular movement, vibration attenuation, and stress relief. Support requirements defined in the tender. Coupling or fitting that allows axial displacement, rotation, and at least 1 degree of angular movement of the pipe without inducing harm on the pipe. For pipe diameters of 8 in. and larger, the angular movement shall be permitted to be less than 1 degree but not less than 0.5 degrees." (NFPA 13-2007 3.5.4)

e. Grooved End Fittings:

Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.

Fittings shall be supplied with factory grooved ends, for use with couplings and flange adapter. Fittings shall be manufactured of ductile iron conforming to ASTM A-536, forged carbon steel conforming to ASTM A-234, or factory fabricated from carbon steel pipe conforming to ASTM A-53. Fittings shall be manufactured to the dimensional standards ASME B16.9. Orange enamel coated or galvanized.

f. Flexible & Rigid Coupling – General Requirements

i. Flexible coupling shall provide a water or airtight joint between pipe segments or pipes and fittings and shall be UL/FM approved.
ii. Flexible pipe couplings are expected to exhibit a service life at least equal to the other pipe fittings used in a fire protection system.
iii. The dimensions of a flexible pipe coupling shall allot its use with standard pipe schedules used in fire protection systems. The minimum wall thickness for 8 inches and larger pipes for use with couplings requiring rolled-groove pipe ends shall be 0.188 inches.
iv. All Flexible pipe couplings shall be designed for a rated working pressure of minimum 16 bar or greater as indicated on drawing or specified else where.
v. The coupling shall be able to withstand a temperature of 800 ˚C in both wet and dry conditions so that the coupling shall maintain the integrity of the pipe.
vi. Gasket materials shall be suitable for continuous water and air service in the temperature range of -40 to 148.9˚C.They shall be pliable, smooth and free of obvious surface porosity and mold flash.
vii. When required by the given design, flexible pipe coupling halves shall mesh together with no interferences.
viii. The coupling shall be resistant to corrosion by salt spray and it shall be tested as per BS 2011: Part 2
ix. Couplings Hydrostatically pressurized to their maximum rated working pressure shall not leak or otherwise fail when subjected to the required bending moments listed below in the table.
x. Flexible pipe couplings 12 inches(304.8 mm) and smaller shall be closed by blind test nipples . The assembly shall then be filled with water and mounted spanning two supports 0.6 meters apart. The assembly shall then be hydrostatically pressurized to the maximum rated working pressure of the coupling and held at that pressure throughout the test. Load shall be vertically applied at the center of the coupling until the maximum required bending movement as listed in the table below is

reached. With this test configuration, the moment arm is 0.3 mts and the load which must be applied to the coupling is numerically equal to twice the required moment. No leakage shall occur at the maximum bending moment.

xi. Contractor to submit the detailed calculation for Engineer's / Client's approval for numbers & location of couplings.

Sl.no	Coupling Size(mm)	Required Bending Moment(N.m)
1	25.4	624
2	31.8	895
3	38.1	1105
4	50.8	1566
5	63.5	2339
6	76.2	3295
7	88.9	4115
8	101.6	5003
9	127	7159
10	152.4	9674
11	203.2	15409
12	254.0	20256
13	304.8	30051

g. Hole-Cut Branch Outlets:

Branch reductions on 2"(DN50) through 6"(DN150) & 8 "(DN200) header piping shall be using,

a. **Weldolet fiiting** confirming to ASME B16.11 shall be used for branch off connection to but welded branch pipes.
b. **Threadolet** fitting confirming to ASME B16.11 shall be used for branch off connection to threaded branch pipes.

1.3 Execution:-

A. Jointing:-

(a) Screwed Joints

Do not damage fitting surface, remove burrs and ream smooth.

(i) Screw joints should be factory made with external taper threads/ parallel internal threads properly cut to IS-554.All site cut threads to be equal to "factory" made.
(ii) All screw joints should be executed to cover the complete length of the "useful thread" as recommended by IS-554.
(iii) Make joints using suitable compound. Clean joint thoroughly of excess jointing material. Jute & holdtite shall be used and apply to male threads only.
(iv) The use of cotton threads roll is not permitted.
(v) Threads shall be full and clean cut and burrs formed in cutting shall be reamed. In screwing up the pipe, care shall be taken that the pipe does not extend into the fitting obstructing the waterway. Joint compound shall be applied to the threads of the pipe and not to the fittings or sprinklers. Pipe shall be straightened before installation to prevent pockets.

(b) Welded Joints

(i) Whenever welding piping connects to equipment, valves or other units connecting joints, match the pressure rating of the pipe flanges with the pressure rating of the flanges on the equipment requires maintenance, servicing, or possible removal.

(ii) Welding process: All sizes use metallic arc process. Make joints between different piping materials with adapter fittings of a type suitable for the purpose intended.
(iii) Make joints between pipes of dissimilar metals with dielectric union or flanges.
(iv) A one-piece reducing fitting shall be used wherever a change is made in the size.The use of bushings or reducing flanges will not be permitted.
(v) Unions shall be used only on pipes 50mm and smaller, and provided at connections to each piece of equipment for easy dismantling.
(vi) All control valves, pressure reducing valves, check valves, water flow switches, pressure switches, etc., shall be easily accessible for maintenance and removal.
(vii) Pipe 80 mm in length and less is considered a nipple. All nipples shall have a nonthreaded area for gripping with wrench.
(viii) All piping systems shall be flushed free of foreign matter with clean water and left with strainers clean upon completion of the work.
(ix) All mechanical couplings shall be installed according to manufacturer's instructions.
(x) Welded Joints in horizontal piping: Joints of G.I. pipe of size 50 mm and above shall be butt welded or flanged. Joints of G.I. pipes less than 50 mm dia. shall be with conventional heavy class screwed pipe and fittings. Joints between G.I. pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. But welding without "V" groove shall not be permitted. All joints in the pipeline with screwed fittings shall be seal welded after testing and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

(c) Flanged joints (50mm dia and above). All flanges shall conform to IS: 6392-2003 Table 17 as applicable. Flanged joint shall be made with 3 mm thick insertion rubber washer/ gaskets, bolts and nuts conforming to IS: 1367 (Galvanized). Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Employer's Representative. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings. Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.
(d) Unions (up to 50 mm dia): Approved type of dismountable unions shall be provided on pipe lines of 40 mm dia and smaller dia, in locations similar to those specified for flanges.
(e) Vertical Piping: Grooved flexible couplings and fittings of approved manufacturer shall be provided for all risers piping as mentioned in 1.2.

B. General welding requirements.

a. All welding shall be generally in accordance with B.S. 4515: 1965 (Specification for field welding of Carbon steel pipelines.) This will be modified where appropriate for other materials and may be relaxed or varied by order of the Employer's Representative, provided that the Contractor has made a reasonably comprehensive request for an alternate.
b. 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.
c. 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.
d. Where oxyacetylene cutting equipment or any welding plant is being used by an operative for any of the works defined in the contract documents, then fire extinguishers shall be supplied and carried as part of the equipment. The operators of cutting and welding equipment shall be trained in the use of the fire extinguishers which they carry and all extinguishers shall be fully charged and ready for use. In all cases, extinguishers shall be positioned immediately adjacent to the position where cutting and welding is being carried out and shall be readily accessible for use in the event of an emergency.
e. All accommodation, benches, tools, welding plant, acetylene, oxygen or electricity, filler rods and electrodes (different quality for root and final welding), which are necessary for installations where welding is required shall be provided as part of this contract.
f. Cutting of pipe with oxyacetylene shall not be permitted on site.
g. All welded pipe assemblies shall be constructed so that individual welded joints do not affect each other. The distance between the centres of adjacent welds shall be not less than twice the bore diameter of the pipe.
h. No welded joints shall be left partially completed. Any joints tacked in position must be promptly finished within the working day. The Employer's Representative will reject all work not done in accordance with this instruction.

i. 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.
j. Where pipes with longitudinal seams are specified, pipe seams shall be arranged such that adjacent seams are opposed 45 deg. from each side of top dead centre and branches shall be made only with weldable fittings.
k. All filler metals 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 Employer's Representative samples of filler rods to be used shall be submitted to him 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.

C. Anti-corrosive tape wrapping for underground pipes.

All underground buried pipes shall be initially brushed to remove all foreign matter and apply the primer over the pipe. Primer shall be allowed to dry until the solvent evaporates and surface becomes tacky .Anti corrosive tape wrapping 4mm thick and 150/250mm wide shall then be wound in a spiral fashion and bonded completely to pipe by thermo fusion process. Overlap shall be maintained at 50 mm. Wrapping of anti-corrosive tape apply shall be as follows at pipe joint overlap:

a. Surface Preparation - The pipe surface shall be cleaned by a wire brush.
b. Application of Primer - Primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.
c. Application of anti-corrosive 4 mm Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 15 mm.
d. Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm.
A final coat of White wash with water based cement paint is done immediately over the entire coated pipe.

D. Excavation

a. Excavation for underground pipe lines shall be as required at site. Pipe lines shall be buried to a minimum depth of 1000 mm.
b. Wherever required, Contractor shall support all trenches of adjoining structures with adequate timber supports.
c. On completion of testing and coating & wrapping trenches shall be refilled and compacted with excavated earth in 15 cms. Layers and consolidated to restore ground condition to original status. Prior to excavation contractor shall ensure that no adjoining structure or pipeline is affected / damaged.

E. Painting

a. All Hydrant and Sprinkler pipes shall be painted with post office red color paint. All G.I pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc.
b. Painting shall be expertly applied; the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

c. All pipes above ground and in exposed locations shall be painted with two coat of Etching type primer and two or more coats (each of 75 microns) of synthetic enamel paint of approved shade & make.
d. Pipes shall be initially brushed to remove all foreign matter before applying paint / primer.

e. Pipes (buried) shall be initially brushed to remove all foreign matter and apply the primer over the pipe. Primer shall be allowed to dry until the solvent evaporates and surface becomes tacky. Tape 4mm thick and 150/250mm wide shall then be wound in a spiral fashion and bonded completely to pipe by thermo fusion process. Overlap shall be maintained at 15mm

F. Tests for welder qualification

a. The purpose of the welder's qualification tests is to determine the ability of the welders to make sound and acceptable welds. Before any site welding on the contract is allowed, each proposed welder shall carry out the tests required in the presence of the certifying agency.
b. Any weld test specimens which have been suitably marked and approved shall be kept on site by a responsible person, so that they can be produced at any time, at the request of the Employer's Representative.
c. All accommodation, benches, tools, welding plant, acetylene, oxygen, electricity, test pieces, filler rods, electrodes, facilities for cutting and grinding, polishing, bending and examining, which are necessary for welders qualification tests shall be provided by the Contractor. In the absence of any facilities for inspecting the welds, the Employer's Representative may submit the finished samples to an independent laboratory for testing at the Contractor's expense
d. Under no circumstances shall a welder be employed on the contract, either on or off the site for welding operations other than those for which that welder is qualified.

e. Copies and records of all test reports shall be promptly given to and kept by the Employer's Representative.
Even welders holding a certificate for welding are to be tested at this job site in full accordance with the specifications.

G. Testing of Pipe work installation

a. Testing of welded pipe work installation shall be by non destructive test method.
b. If a weld fails the testing requirements, then two additional welds made by the same operative shall be tested, at no cost to the contract. If both additional welds are successful then, in the case of destructive testing, the cost of making good shall be at no cost to the contract.
c. If either of the two additional welds fails the test requirements, then further tests on other or all of the welds made by that operative shall be carried out, at the Employer's Representative's discretion. All costs resulting from either of the two additional welds failing the test requirements shall be at no cost to the Contract.
d. If either of the two additional welds fails, then the operative concerned shall not make any further welds on any service unless approved by the Employer's Representative. The detailed requirements concerning testing shall be as follows:
e. Non-destructive testing (Die penetration testing) shall be carried out by a specialist company approved by the Employer's Representative, but paid by the Contractor.
f. All the pipe shall be pressure tested at 1.5 times the working pressure of the pumps.

2. Valves and Accessories

2.1 Material

A. Valves shall be provided at locations as indicated in drawings and as required.
B. All valves to be selected for working pressure 1.5 times higher than system working pressure.
C. All valves are to be located for easy access. All valves shall be rated properly to suit the pressure rating for the piping system (As per approved hydraulic Calculation), where the valves are being installed and shall be supported wherever necessary with Hot dipped galvanized MS brackets.
D. Valves shall comply with IS: 780 (Class I) for C.I sluice valves and IS: 778 for G.M valves and tested.
E. Flanges shall be of same material that of the pipe.
F. All Valves shall be factory tested at 1.5 times the design working pressure for the piping system, where the valves are being installed.

Sr.No.	Type of Valve	Size	Body Construction	Ends
a.	Ball Valves	15 mm to 40 mm	Brass	Screwed
b.	Isolating Valve (Gate Valves)	15 mm to 40 mm	Brass	Screwed
c.	Isolation Valve (Butterfly Valve)	50 mm and above	Cast Iron	Flanged
d.	Auto Balancing valve	(15-40mm) (50 mm to above)	Ductile Iron/ Cast Iron	Screwed Flanged
e.	Y Strainers	(15-40mm) (50 mm to above)	Brass/ Cast Iron	Flanged
f.	Pressure Relief valve	All sizes.	Gun Metal	Screwed Flanged
g.	Pressure reducing valve	Below 50mm 50 mm and above	Bronze Ductile Iron	Screwed Flanged
h.	Foot Valve	15 mm to 40 mm 50 mm and above	Forged Brass/ Cast Iron	Screwed Flanged
i.	Check valve (swing/sluice)	15 mm to 40 mm 50 mm and above	Brass/ Cast Iron	Screwed Flanged

2.2 Gate Valve/Globe Valve

A. Gate valves used in high pressure (head) piping shall be made of Brass/CI and of suitable class as indicated in specifications, drawings & schematics or higher if required.
B. Supplying, fixing and testing shall correspond to IS: 778-1984, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.
C. Valves shall be tagged with permanent label under hand wheel indicating type or duty.
D. All valves shall have manufacturer's test certificate indicating the date of shop test and other quality control tests with the material used for the same.
E. Gate valve handle shall be in stainless steel 304
F. Gate valves shall be of the size as specified in the BOQ.

2.3 Foot Valves:

A. Foot valves shall be Brass/ cast iron body, (with epoxy coating), brass disc and strainer of approved quality as specified in BOQ.
B. Foot valves shall be spring loaded of stainless steel depending on the requirement.
C. Foot valves seal shall be EPDM.
D. Valves shall be tested physically for free operation before being mounted or assembled to the pipeline.

2.4 Butterfly Valves:

A. Butterfly valves used in high pressure (head) piping shall be made of C.I material of suitable class as indicated in specifications, drawings & schematics or higher as required.
B. Butterfly valves shall be slim seal, short wafer type with standard finish. Valves shall be suitable for mounting between flanges drilled to ANSI 125.
C. Valve shall consist of disc pivot and driving stem shall be in one piece centrally located. Disc shall move in bearings on both ends with 'O' ring to prevent leakage.
D. Seat shall be Stainless steel / Ductile iron based on pressure classification and molded with EPDM and shall line the whole body.Spindle shall be AISI 41 steel.
E. Valve for normal application shall be suitable for a 1.5 times working pressure to suit the application and service and shall be complete with flow control lever and notches, factory machined companion flanges and bolts and nuts.
F. Valves shall conform to BS 5155 with electro steel nickel coated SG Iron (N) and seat material EPDM.

2.5 Check Valves (Non-Return Valves):

A. Double Swing Check Valves / 80mm dia and above shall be Cast iron/ DI Double flanged type with non-rising spindle. Spring and hinge pin shall be of SS 304.
B.
C. Non Return Valves in exposed locations e.g. pump house etc. shall be provided with Cast Iron Wheels.
D. Valves on G.I. Pipes 50 mm and below shall be Brass valves.
E. Valves shall confirm to and marked IS: 778.
F. Valve shall be suitable to withstand system pressure and shall be tested at 1.5 times system pressure.
G. Valves shall be measured by numbers and shall include matching flanges, rubber gaskets, bolts, nuts, washers and all items necessary and required and as given in the specifications to complete the work to the satisfaction of Owner/ Architect/ Employer's Representative.

2.6 Ball Valves (

A. Ball valves shall be of high pressure type and shall be of sizes as specified in the BOQ. Normal size of a ball valve shall be that, corresponding to the size of the pipe to which it is fixed.
B. Ball valves shall be full bore, two piece designs.
C. Ball valves shall have body & bonnet of brass material.
D. Ball and the stem shall be of Brass confirming to IS 6912 respectively. Ball shall be hard chrome plated.
E. Handle shall be of M.S with PVC Jacket.
F. Seat and gland packing shall be of PTFE.

2.7 Equilibrium float valve (For Storage Tanks)

A. Equilibrium float valves with ball floats to be fixed in storage tanks shall consist of hot pressed brass valve body(up to 50mm dia) and Cast iron (above 50mm dia), Stainless steel lever arm, and copper balls (26 SWG) screwed to the arm integrally.
B. The ball float shall be round and of Copper material. It shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers.
C. The size, construction and weight of Float valves and ball float shall be suitable for desired working pressure operating the supply system.
D. Float valves shall generally conform to IS specification No.1703-1977. Weight of ball float and its size shall be as per IS specification.

2.8 'Y'-Strainers

A. Strainers shall be preferably of the approved 'Y' type with C.I. construction and of suitable class as indicated in drawings and schematics or higher as required.
B. Strainers shall incorporate removable stainless steel with 3.175 mm (1/8") or minimum diameter perforations and a permanent magnet.
C. Strainers shall be provided with flanges.
D. Strainers shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of all screens without disconnection of the main pipe.
E. The pocket should point vertically downwards , this ensures that the removed debris is not drawn back into the upstream pipe work during low flow conditions.
F. Although it is advisable to install strainers in horizontal lines, this is not always possible, and they can be installed in vertical pipelines if the flow is downwards, in which case the debris is naturally directed into the pocket.
G. If the end connections are threaded or designed for soldering and brazing , the pipes shall be straight and not at an angle or offset.
H. If the end connections are flanged care shall be taken that the flanges of the connecting pipes are square with the pipe so that no undue stresses are put on the strainer or piping while tightening the bolts.

2.9 Pressure Relief Valve.

Relief valve shall be provided on the pump discharge header and outlet of Pressure Reducing Stations. The relief valve shall have adjustable setting in range suitable for operating range of the pump. The relief valve outlet shall be led back to the tank in Pump room. Relief valve body shall be of ductile iron (65mm and above) / Gun metal (up to 50 mm). Relief valve sizing shall be done considering pump characteristics. Pressure Relief valve body shell pressure requirement to be tested at 1.5 times of the working pressure & it shall be FM/UL listed. The valve shall be spring operated & set to operate as per field requirement. Type of Valve (Globe OR Angle) shall be selected based on the space ability at site. Pressure relief valve shall be inclusive of

a. Pressure Relief Valves, shall be factory assembled and fully trimmed valve arrangements for relief of excess water pressure. These valves are typically used to automatically relieve excess pressure in a fire protection
b. Pilot-controlled, Valve maintains a relatively constant system pressure at the pump discharge as flow demands change. Pressure Relief Valve may be field-set to a nominal relief "set pressure"
c. The body construction shall be blue-coated ductile iron per ASTM A536-77, Grade 65-4512. Diaphragm shall be made of Nylon fabric-reinforced, natural rubber per ASTM D2000. Diaphragm Cover Fasteners shall be of Galvanized carbon steel. Pilot Valve shall be of Cast bronze and stainless steel with nylon fabric reinforced, natural rubber per ASTM D2000 diaphragm.

2.10 Shank Reducers

A. Shank reducer (Male type) 63 mm dia SS- TO IS 3444 Gr.1 for connection purpose of HOSE REEL HOSE
B. The shank reducer shall be connected with the Hose pipe
C. The hose pipe shall be double braided Type 2 .
D. When tested in accordance to the standards the pipe shall show no leakage , rupture at the proof pressure.

2.11 Pressure reducing stations

A. PRV shall be complete with station having strainer on suction, isolation valve , pressure gauge before and after PRV along with bypass line. By pass line shall be provided with isolation valve(Normally closed).
B. Valves shall maintain a constant downstream pressure regardless of fluctuations in demand and shall also prevent a pressure rise when demand is zero. Valve shall be suitable for horizontal or vertical installation.
C. No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of ductile iron.
D. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-Section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface.

The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used

E. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of Sufficient diameter to withstand high hydraulic pressures, shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

F. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphram must withstand a Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.

G. The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 6" and smaller size valves shall be threaded into the cover and body. Valve seat in 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valvestem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including cast material shall be of approved manufacture.

H. The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.

I. The valve manufacturer shall be able to supply a complete line of equipment from 1 1/4" through 24" sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a computerized cavitations chart which show flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitations damage.

J. Valves shall be single-seated, hydraulically - operated. Valve body and cover shall be Ductile Iron Class 150/Class 300, flanged. Trim shall be bronze. Valve seat shall be replaceable. There shall be no external packing glands.

K. Valves shall have integral low flow by-pass line.

L. Main valve and all trim shall be factory- assembled into one unit.

2.12 Gauges

Provide pressure gauges, conforming to the requirements of IS-3624:1987, where indicated on the drawings and in accordance with the schedule given below. All gauges shall be provided with snubbers. Gauges shall have 100mm diameter dial, white coated with black figures and graduations. Shutoff cock shall be provided between gauge and piping to permit gauge removal while system is under pressure.

Pressure gauge shall be gun metal bourdon type Glycerine filled with gun metal isolation ball valve , tapping and connecting pipe and nipple. Gauges shall have graduation such that at normal working pressure the needle is in the centre of the field

Gauge Location (including but not limited to)

- o Inlet and Outlet of Pumps
- o Top and bottom of all hose reel risers.
- o Air vent at top level.
- o And as shown in the drawings

Mount gauges no higher than 1.5m above finished floor. All gauges shall be calibrated in kg./sq.cm/bar. to a maximum of not less than 1-1/3 times and not more than 2 times the operating pressure as per Engineer/Client approved

2.13 FIRE BRIGADE CONNECTION

The storage tank shall be provided with a 150 mm fire brigade pumping connection to discharge at least _____ litres / minute into it. The connection shall be fitted with stop valve in a position approved by the Project Manager. An overflow connection discharging to a drain point shall be provided from the storage tank.

The fire brigade connection shall be fitted with four numbers of 63mm instantaneous inlets in a glass fronted wall box at a suitable position at street level, so located as to make the inlets accessible from the outside of the building. The size of the wall box shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken. Each box shall have fall of 25mm towards the front at its base and shall be glassed with wired glass with "FIRE BRIGADE INLET" painted on the inner face of the glass in 50 mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass.

In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets direct to hydrant main so that the fire brigade may pump to the Fire Pump header in the even of the hydrant or sprinkler pumps being out of commission. The fire brigade pump shall charge the risers in this event. The connection shall be fitted with a sluice valve. Location of these valve shall be as per the approval of the Project Manager.

2.14 Flow Switch

Red powder coated finish with cover held in place with tamper resistant screws and suitable for indoor or outdoor use with factory installed gasket and die-cast enclosure housing.

Flow switches shall be paddle type SPDT snap acting contacts rated 10 A @ 220 . The paddle shall be made of either brass or phosphor bronze terminated in a screwed terminal connector. The entire unit shall be encased in cold drawn steel enclosure and the maximum operating pressure of the parts in contact with the liquid shall be consistent with the system pressure. Flow Switch shall be UL/FM approved.

1. Vane type water flow alarm switch with retard detectors shall be installed on system piping as designed on drawing / or as specified herein.
2. Detectors shall mount on any clear pipe span of the appropriate nominal size, either vertical up flow or horizontal run, at least 6'' from any fitting which may change water direction, flow rate or pipe diameter or no closer than 24'' from valve or drain.
3. Detectors shall have sensitivity in the range of 4 to 10 gallons per minute & static pressure rating of 31 bars for 2'' to 8'' pipes.
4. Detector shall respond to water flow in the specified direction after a present time delay which is field adjustable.
5. The delay mechanism shall be sealed mechanical pneumatic unit with visual indication of actuation.
6. The actuation mechanism shall include a polythene vane inserted through a hole in the pipe & connected by mechanical linkage to the delay mechanism.
7. Output shall consist of dual SPDT switches (Form C contacts).
8. Two conduit entrances for standard fitting of commonly used electrical conduit shall be provided on the detectors.
9. A grounding provision is provided. Unless noted enclosures shall be NEMA 4 listed by Underwriters Laboratories Inc. for Indoor or outdoor use.

2.15 Installation Control Valves (Alarm Check Valve)

The sprinkler system shall incorporate one or more installation control valves as per IS:15105 standard & TAC. Alarm valve to be Ductile iron double seated clapper check valve with grooved seat design. The trim shall be with galvanising fittings and brass/bronze valve rated for 16 kg/sq.cm or 1.5 times working pressure whichever is greater. Trim shall be variable pressure with retardant chamber. Minimum working pressure to be 16 kg/sq.cm .Valve shall be factory hydro tested at 35 kg/Sq.cm. Alarm valve to be UL listed, FM approved. The Alarm check valve shall be suitable for installation under both variable and constant supply pressure conditions.ICV shall be UL/FM listed

Installation valve assemblies comprising of following:

i) Main Alarm check Valve
ii) Gate/Butterfly valve
iii) In and out pressure gauges
iv) Precision retarding chamber
v) Supervisory switch, pressure alarm switch, flow switches
vi) Test connection of adequate size with valve and orifice plate with pressure connections.
vii) Alarm Water motor gong with necessary piping isolation valve and strainer and drain.
viii) Angle main drain valve, check valve, ball valves & indirect drain etc
ix) Restriction assembly.
x) Pressure relief trim kit

The installation control valve shall be straight through type suitable for wet pipe sprinkler systems. Valves shall be of Ductile iron with gun metal/bronze internals and suitable for vertical or horizontal installation with flanged ends.

There shall be two pressure gauges, one for the mains side and another for the installation side. Each gauge shall have pressure damping brass piping with gunmetal gauge and valve A test connection of adequate size as shown on drawings or as approved shall be provided with a shut off gate valve, check valve, flow switch ,an orifice plate with pressure connections. The discharge from the test connection outlet shall be let to the nearest sump or drain as shown on drawings or as directed.

The mains water motor and gong shall be of cast gunmetal body and internals. The valve shall have associated gunmetal gate valve, strainer, retardant chamber, restriction assembly preceding the water motor. The water motor and gong shall be located on the discharge lead as shown in drawings or as directed by consultant.

The system shall include all accessories like flow switches and Tamper switches ,pressure switches etc. for satisfactory operation of ICV

2.16 Flexible Drop Connectors for Sprinkler:

In lieu of rigid pipe offsets or return bends for sprinkler drops, the unbraided Flexible Droppers shall be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a unbraided type 304/316 stainless steel hose piece, 1" NPT Male threaded adapter for connection to header piping and a 1/2" or 3/4" NPT Female adapter for connection to the sprinkler head. Unions shall be provided on both ends of the flexible hose for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece bracket that can be installed without the use of tools and have a 3” minimum bending radius for installation in narrow or confined spaces. The unbraided flexible droppers shall withstand the pressure equal to 1.5 times the system pressure.

2.16 WATER METERS

1) The flow meter shall be specifically designed for the monitoring flow of fire protection systems. It shall consists of a calibrated Venturi with attached dial size not less than 100 mm dial meter.

2) Flow meter shall be directly mounted pipeline and can be able installed in horizontal, vertical and sloped pipes. Flow meter Construction shall be robust, with minimal obstruction to the flow, with minimum pressure loss.

3) Flow meter accuracy shall be in the range of + 2% of full scale.

4) Flow meter shall be UL / FM Approved.
5) Venturi shall be made of 1018 or 1026 Solid Carbon Steel (machined), Carbon Steel Thick Wall Pipe and /or Tube (machined) Material Certs. Available. Powder Coating shall be of “Red”.

6) Meter shall of ALUMINUM 4” Dial, 1/4 MNPT Connections 304SS Case with Rubber Ring, Glass Window buna-n Seal.

7) Brass valves and fittings shall be of BRASS [CA360]. Rubber hose rating shall not be less than 500 PSI.

3. Hydrant System

3.1 Material

A. Internal Hydrants & Cabinet

a. Contractor shall provide on each floor, internal hydrants consisting of one no. Stainless steel fire hydrant double landing valve with 63 mm dia. outlets and 100 mm inlet conforming to and marked IS:5290 (Type 'B') with Cast Iron Wheels.
b. Landing Valves shall have flanged inlet and instantaneous female type outlets.
c. Instantaneous outlets for Fire Hydrants shall be of standard approved pattern and suitable for Fire Brigade hose of 63 mm with couplings conforming to and marked IS: 5290. Alongside each hydrant; there shall be a hose box to accommodate two numbers of IS 636 hose, each of 15 m length.
d. Contractor shall install orifice plate flanges on all hydrants having excessive pressure more than 3.5 bars
e. Orifice plates shall be fabricated with plain central hole without burrs.
f. The bore of the orifice shall be designed by the Contractor and calculations to be submitted to Owner/ Architect/ Employer's Representative for approval.
g. Branch pipes shall be Stainless steel type of 63 mm dia with nozzle of 20 mm dia, as per IS 903.
h. Hose cabinet shall be of 4 mm thick glass fronted with hinged door & lock. The cabinet shall be made of 16 gauge thick MS sheet and spray painted to shade No. 536 of IS:5.
i. The hose cabinet shall be of size to accommodate the following:

i. Landing Valves (Single/double headed as specified in drawing/CFO NOC)
ii. Canvas Hose pipe
iii. Hose reel (30/36 mtr as required.)
iv. Branch pipes, nozzles (2 sets)
v. Orifice Plate.
vi. Fire man's axe and hand appliances
vii. Fire extinguishers
viii. Shank reducer with rubber hose

B. External Hydrants

a. External Hydrants (Yard Hydrants,MOC Stainless Steel) shall conform to and marked IS:5290 (Type' A').External hydrants shall consist of a stand post 100mm NB, duck foot bend, a single headed oblique pattern hydrant valve of 63mm NB, instantaneous female type coupling, gun metal cap and chain.
b. Alongside each hydrant, there shall be a hose box to accommodate two numbers of non percolating rubber reinforced line fire hose pipe (IS: 636) each of 63mm dia. and 2 Nos of 15 M long conforming to IS: 8423 complete with instantaneous ISI marked Gun-Metal Male & Female couplings (IS: 903) and 1 No. 63mm dia. ISI marked Gun-Metal Short Branch Pipe with nozzle (IS: 903).
c. Contractor shall install orifice plate flanges on all hydrants having excessive pressure (more than 3.5 bar), Orifice plates shall be with plain central hole without burrs.
d. The bore of the orifice shall be designed by the Contractor and calculations to be submitted to Owner/ Architect/ Employer's Representative for approval.
e. The hose cabinet shall be of size to accommodate the following:

i. Single/Double headed yard hydrant valve
ii. Hose pipe (2 length of 15 m)
iii. Branch pipes, nozzles (2 sets)
iv. Fire man's axe
v. Orifice plate

C. First Aid Hose Reels

a. Contractor shall provide standard First-aid Hose Reel with 20 mm dia. high pressure braided rubber hose 30 M long with gun-metal adjustable jet spray nozzle and manual operating valve, all mounted on circular hose reel of heavy mild steel construction with Cast Iron Bracket having a swivel hinge @ 180 degree C while pooling the hose in either direction.

b. Hose reel drum shall strictly conform to IS: 884-1969. A lock shield type isolating with PRV shall be installed on the fire hose reel supply piping adjacent to each hose reel. Wall bracket shall be of M.S. with anti corrosive painting.

D. Branch Pipe, Nozzle

a. Branch pipes shall be of Stainless steel with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring to fit into the instantaneous coupling.
b. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm.
c. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard - 903.

E. Fire Hose Cabinets (FHC) Concealed type

a. Cabinets shall be concealed type made of masonry construction, sized to accommodate Double landing valve(s), 15m long hoses, first-aid hose reel , 2 Nos fire extinguisher (type shall be as indicated in drawings or as per CFO NOC), branch pipe and nozzle , fire man axe and fire accessories mentioned in the description sheet.
b. All fire cabinets shall be painted 'Fire Red' from outside. The inside of the cabinet shall be white baked enamel.
c. Hose cabinets shall have glass front door with 4 mm thick clear glass and powder coating `Red' finish outside and `White' inside. There shall be breakable glass type feature to keep key.
d. Fire cabinets shall have doors fabricated by M.S. sheet of 16 SWG with glass-fronted door (glass shall be 4mm thick) and size of the shutter shall be 1500mm x 1200mm minimum.
e. Door shall be in two leaves with necessary stiffeners. Door shall be powder coated finish of `Red' outside and `White' inside and on the glass label of "FIRE" shall be stuck. The letter size shall be min. 75 mm height. There shall be built in breakable glass type feature to keep key.

F. Fire Hose Pipe (FHP)

a. Rubber reinforced lined fire hose pipe (as per IS: 636) of 63mm dia and length as described in BOQ.
b. The Fire Hose Pipe shall be rated for burst pressure of 37.5 kg/sq cm. Hose shall be complete with ISI marked brass male and female coupling (IS:903) bound and riveted to hose pipe with copper rivets and 1.5mm copper wire

G. Drain Valves

a. Drain valves shall be of high pressure type and shall be of sizes as specified in the BOQ. Normal size of a ball valve shall be that, corresponding to the size of the pipe to which it is fixed.
b. Drain valves shall be full bore, two piece designs.
c. Drain valves shall have body & bonnet of brass material.
d. Ball and the stem shall be of Brass confirming to IS 6912 respectively. Ball shall be hard chrome plated.
e. Handle shall be of M.S with PVC Jacket.
f. Seat and gland packing shall be of PTFE.

H. Auto air vent

a. Brass material Automatic air release valve with stop cock screwed inlet connection and drain arrangement with 15mm diameter shall be provided on every hydrant, sprinkler and wet risersTo be risers at top most point.

I. Valve Chambers

a. Contractor shall provide suitable brick masonry chamber of size as indicated in bill of quantities in cement mortar 1:4 no on cement concrete foundation 150mm thick of PCC 1:2:4 mix, 15mm thick cement plaster inside and outside finished with a floating coat of neat cement with Cast Iron heavy duty frame and cover including excavation, back filling complete.

J. Pressure reducing Station

a. Valves shall maintain a constant downstream pressure regardless of fluctuations in demand and shall also prevent a pressure rise when demand is zero. Valve shall be suitable for horizontal or vertical installation.
b. No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of ductile iron.
c. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-Section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used
d. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of Sufficient diameter to withstand high hydraulic pressures, shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.
e. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphram must withstand a Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.
f. The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 6" and smaller size valves shall be threaded into the cover and body. Valve seat in 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including cast material shall be of approved manufacture.
g. The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.
h. The valve manufacturer shall be able to supply a complete line of equipment from 1 1/4" through 24" sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a computerized cavitations chart which show flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitations damage.
i. Valves shall be single-seated, hydraulically - operated. Valve body and cover shall be Ductile Iron Class 150/Class 300, flanged. Trim shall be bronze. Valve seat shall be replaceable. There shall be no external packing glands.
j. Valves shall have integral low flow by-pass line.
k. Main valve and all trim shall be factory- assembled into one unit.
l. PRV shall be complete with station having strainer on suction, isolation valve , pressure gauge before and after PRV along with bypass line. By pass line shall be provided with isolation valve (Normally closed).

K. Orifice Plates

a. The orifice plate designed as per ISO5167 or Equivalent Standard is supplied along with a set of flanges, gaskets, studs, nuts & plugs. Two pairs of flange tapings are generally ½" NPT(F).The

flanges are to be welded in the pipeline with sufficient upstream and downstream lengths and properly bolted.

b. The Diameter of such orifice shall not be less than 50% of the dia of pipe into which it is to be fitted, which shall not be less than 50mm dia.
c. These orifice plates must be of stainless steel with plain central hole without burrs, and the thickness shall be 3mm for pipe size up to 80 mm, 6 mm for pipes from 80 to 125 mm dia and 9 mm for pipes greater than 125 mm dia as per Orifice plate thickness shall be as per IS 15105:2002, table No-16.
d. For restricting pressure in the hydrant system, orifice plates of appropriate sizes shall be fitted at different floor levels, at the branching points from Riser Main.
e. Orifice plate must have a projecting identification tag indicating working inlet and outlet pressure.
f. The orifice plate shall fitted at a distance of not less than two pipe internal diameters down stream of the outlet from any elbow or brand.
g. Contractor shall submit the design for engineer's approval and identify location on drawing before installation.

L. Fire Brigade Connections

a. Fire brigade connection shall be as per IS: 5131.
b. Contractor shall provide four numbers of 63mm NB gunmetal Fire Brigade type instantaneous inlets with built in check valves and 150 mm dia. flanged outlet connection with butterfly and check valves.
c. The collecting heads shall be connected to fire water wet risers for the use of local Fire Brigade. Fire brigade connection shall be enclosed in a suitably sized glass fronted box mounted at a suitable position.
d. It shall be connected to the storage tank with a 150 mm fire brigade pumping connection to discharge at least 2275 liters / minute into it.
e. This connection shall not be taken directly into the side of the storage tank, but arranged to discharge not less than 150 mm above the top edge of the tank such that the water flow can be seen.
f. The connection shall be fitted with stop valve in a position approved by the Employer's Representative.
g. An overflow connection discharging to a drain point shall be provided from the storage tank.
h. The fire brigade connection shall be located as to make the inlets accessible from the outside of the building.
i. The size of the wall box kept beside the inlet shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken.
j. Each box shall have fall of 25mm towards the front at its base and shall be glassed with wired glass with "FIRE BRIGADE INLET" painted on the inner face of the glass in 50 mm size block letter.
k. Each such box shall be provided with a steel hammer with chain for breaking the glass.
l. In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets direct to hydrant main so that the fire brigade may pump to the hydrants in the even of the hydrant pumps being out of commission.
m. The connection shall be fitted with a sluice valve and reflux valve. Location of these valves shall be as per the approval of the Employer's Representative.
n. Four way collecting head with two numbers 63 mm instantaneous type inlets shall be connected to the sprinkler header

3.2 Execution

A. Scope of work under this section comprises of furnishing all equipment, appliances, materials, labour necessary and required to install/ modify Wet Riser Fire Hydrant System / Components as required by the drawings, specified herein or given in the bill of quantities.
B. Without restricting to the generality of the foregoing the Fire Hydrant System shall include the following:-

a. Galvanized iron, Class C (heavy) (wrapped and coated for underground piping) mains including valves, fittings, grooved, yard hydrants and appurtenances, as specified.
b. Galvanized iron, Class C (heavy) pipe mains/risers internal exposed including valves, fittings, flanges and appurtenances, as specified.
c. Landing valves, hose reels, hose cabinets, hose pipes, orifice plate, branch pipes.
d. Fire brigade connection and connections to pumps and appliances.
e. Fire Pumps, Jockey Pump, Electric Motors, Diesel Engine Pumps, Booster Pumps Control Panels, Valves, Air Vessels, Cabling and accessories, as specified.
f. All materials shall be conforming to specifications and subject to the approval of the Owner/ Architect/Employer's Representative.
g. Pipe and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat worke like manner.
h. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
i. Pipes shall be securely fixed to Brick/RCC walls and ceilings by suitable clamps / hangers /sleeves / brackets at intervals specified. Only approved type of anchor fasteners shall be used.
j. Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.
k. Construction of fire water tanks are not part of this package.
l. No jute will be allowed in threaded joints.
m. If header piping is less than 50mm then shoe joints is to be provided.

C. Installation of orifice plate

a. Determine the location & orientation. Sufficient upstream and downstream straight length of pipe must be kept without any restriction like valves, bypass arrangement, thermo – well pockets etc. To get a fully developed flow profile which helps in obtaining the published accuracy per standard.
b. Depressurize the line using site – specific requirements.
c. Loosen all studs and nuts. Remove the studs in one – half of the flange union and spread flange union by turning jackscrews clockwise.
d. Install the Orifice plate with the face marked "INLET" on the tag towards upstream.
e. The orifice plate must be installed concentric with the pipe ID.
f. Install the new gaskets when installing the plate. It is recommended that new gaskets be installed each time the orifice flange union is separated.
g. Release the flange union by turning the jack screws counter–clockwise.
h. Replace the studs & tighten nuts in a star pattern.
i. One pair of tapping must be plugged or closed with an isolation valve.
j. Such orifice plate must have a projecting identification tag.
k. The orifice plate shall fitted not less than two pipe internal diameters down stream of the outlet from any elbow or brand.
l. Contractor shall submit the design for engineer's approval and identify location on drawing before installation.

3.3 Testing and Commissioning

A. **Fire Hydrant System**

a. Pressurize the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump.
b. Open the test line and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.
c. Open hydrant valve and allow the water to below into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically

on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts

d. Switch off the main fire pump and test check the stand by pump in the same manner as the electrically driven pump.
e. When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.
f. Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

4. Sprinkler System

4.1 Material

The entire sprinkler installation shall be designed to make it a hydraulically balanced system. The pressure requirement at typical floors shall be designed for 0.5 to 1.5 bar at each sprinkler outlet and as per the material appproves.

- Pipes fittings and support shall be the same as for Fire Hydrant System.
- Jointing shall be the same as for Fire Hydrant System. All risers shall be installed with Grooved flexible coupling fittings.
- Valves shall be the same as for Fire Hydrant System.
- Orifice shall be the same as for Fire Hydrant System.

A. Auto Air vent:

a. Brass material Automatic air release valve with stop cock screwed inlet connection and drain arrangement with 15mm diameter shall be provided on every hydrant and sprinkler risers at top most point

B. Sprinkler Heads

a. Material Details

Sprinkler Temperature Classification	Sprinkler Nominal Temperature rating	Maximum Ambient Ceiling temperature	Bulb
Ordinary	155 Deg F (68 Deg C)	100Deg F (38DegC)	Red
Intermediate	175 Deg F (79 Deg C)	150Deg F (65DegC)	Yellow

i.

ii. Sprinkler heads shall be made of gunmetal/brass/quartzoid bulb sufficiently strong, in compression to withstand any pressure, surge or hammer likely to occur in the system. The yoke & body shall be made of high quality gun metal brass with arms streamlined to ensure minimum interference with the spread of water. The deflector of suitable design shall be fitted to give even distribution of water over the area commanded by the sprinkler.

iii. The bulb shall contain a liquid having a freezing point below any natural climatic figure and a high coefficient of expansion. The temperature rating of the sprinkler shall be stamped on the deflector & the colour of the liquid filled in the bulb shall be according to the temperature rating as per NFPA standard. The sprinkler heads shall be of type & quality approved by the local fire brigade authority. The inlet shall be screwed.

iv.

v. Sprinkler temperature shall match with table indicated on legend drawings/Equipment schedule

vi. Sprinkler heads shall be provided at appropriate spacing to cover 12 sqm per sprinkler for ordinary hazard and 21sqm per sprinkler for Light hazard areas except upright for which it shall be 9 sq.mt complying to NFPA-13

vii. Spacing's shall be in conformity with the drawings and properly co-coordinated with electrical fixtures and air-conditioning ducts, diffusers and grills and other ceiling services.

viii. Detailed shop drawings for sprinkler system shall be prepared by Contractor and submitted to Owner/ Architect/ Employer's Representative for approval before starting the work.

ix. Temperature rating of sprinkler heads shall be 68 ℃ for conditioned areas and 79 ℃ for non-conditioned areas and kitchen area..

x. Sprinkler head shall be of type and make approved by the Employer's Representative.

xi. The inlet shall be screwed for 15mm dia. as specified. The sprinkler head shall have CFO/ UL/ FM approval or listing.

xii. Sprinkler shall be quick/standard response type for all areas except car park and mechanical areas. herein for car park and mechanical areas it should be of standard response type. For double height areas quick response type sprinkler shall be provided.

xiii. Contractor shall supply 2% spare sprinkler heads and one spanner (not separately payable), neatly installed in a wooden cabinet with glass shutters as approved by the Employer's Representative.

xiv. PVC/Metal guard for protection of sprinkler against accidental mechanical damage shall be provided as approved bymanager

xv. Type of Sprinkler shall be as per BOQ and Drawings.

xvi. Refer Sprinkler Discharge coefficient as per following table.

Table 6.2.3.1 Sprinkler Discharge Characteristics Identification

Nominal K-Factor [gpm/(psi)$^{1/2}$]	Nominal K-Factor [L/min/(bar)$^{1/2}$]	K-Factor Range [gpm/(psi)$^{1/2}$]	K-Factor Range [L/min/(bar)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	20	1.3–1.5	19–22	25	½ in. NPT
1.9	27	1.8–2.0	26–29	33.3	½ in. NPT
2.8	40	2.6–2.9	38–42	50	½ in. NPT
4.2	57	4.0–4.4	59–64	75	½ in. NPT
5.6	80	5.3–5.8	76–84	100	½ in. NPT
8.0	115	7.4–8.2	107–118	140	¾ in. NPT or ½ in. NPT
11.2	160	10.7–11.7	159–166	200	½ in. NPT or ¾ in. NPT
14.0	200	13.5–14.5	195–209	250	¾ in. NPT
16.8	240	16.0–17.6	231–254	300	¾ in. NPT
19.6	280	18.6–20.6	272–301	350	1 in. NPT
22.4	320	21.3–23.5	311–343	400	1 in. NPT
25.2	360	23.9–26.5	349–387	450	1 in. NPT
28.0	400	26.6–29.4	389–430	500	1 in. NPT

xvii. Deviations from the standard or any alternation to the sprinklers or cover plate assemblies before the item reaches on site , may renders the sprinklers inoperative and will automatically nullify approval on site

b. Installation details

Before installation, the correct sprinkler, with correct K factor , temperature rating and response characteristics shall be checked

i. For flush and concealed type sprinklers : Cut the sprinkler nipple so that 15, or 20 mm NPT outlet of the reducing coupling is at the desired location and centered in the opening in the ceiling or wall.

ii. Install not more than one half the sprinkler spacing not less than 102 mm from walls obstructions .

iii. A small amount of pipe joint compound or tape to the external thread of the sprinkler only. Sprinklers with protective caps or bulb shields must be contained within caps or shields before applying any pipe compound or tape.

iv. After installation the sprinkler shall be tested as per the applicable standards

v. Remove the plastic cap or bulb shields after the wall or ceiling finish work is completed where the sprinkler is installed and there is no longer is a potential for mechanical damage to the sprinkler operating elements

vi. For residential flush sprinklers, the ceiling ring can now be installed onto the sprinkler body. Align the ceiling ring with the sprinkler body and thread on or push it on until the flange touches the ceiling.

vii. For residential concealed sprinklers, the cover plate assembly can now be attached.

viii. Remove the cover plate assembly from the protective box, taking care not to damage the assembly.

ix. From below the ceiling, gently place the base of the cover plate assembly over the sprinkler protruding through the opening in the ceiling or wall.

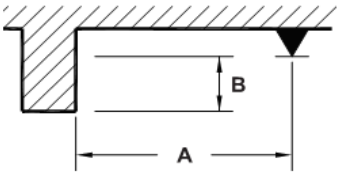
x. Carefully push the cover plate assembly onto the sprinkler, using even pressure with the palm of the hand, until the unfinished brass flange of the cover plate base touches the ceiling or wall.

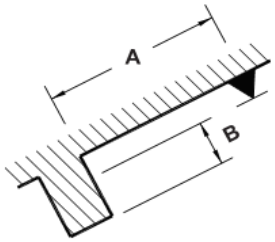
xi. The maximum adjustment available for residential concealed sprinklers is ½" (12.7 mm) [1/4" (6.4 mm) for sprinkler 1/4" (6.4 mm) for sprinkler. If necessary, re-cut the sprinkler nipples.

C. Sprinkler **Spacing**

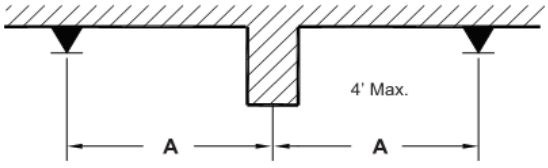
a. Follow below details for sprinkler spacing

Positioning Residential Pendent Sprinklers - Obstructions at the Ceiling



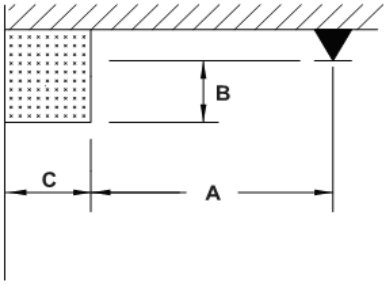


Distance from Sprinkler to Side of Ceiling Obstruction (Dimension A)	Maximum Distance from Deflector to Bottom of Ceiling Obstruction (Dimension B)	
	Inches	mm
Less than 1 ft. 6 in. (Less than 457 mm)	0	0
1 ft. 6 in. to less than 3 ft. (457 mm to less than .94 m)	1	25.4
3 ft. to less than 4 ft. (.91 m to less than 1.2 m)	3	76
4 ft. to less than 4 ft. 6 in. (1.2 m to less than 1.37 m)	5	127
4 ft. 6 in. to less than 6 ft. (1.37 m to less than 1.8 m)	7	178
6 ft. to less than 6 ft. 6 in. (1.8 m to less than 2 m)	9	229
6 ft. 6 in. to less than 7 ft. (2 m to less than 2.1 m)	11	279
7 ft. or greater (2.1 m or greater)	14	356



Residential pendent sprinklers may be located on opposite sides of continuous obstructions up to 4 ft. (1.2 m) wide at the ceiling, as long as the distance from the centerline of the obstruction to the sprinklers (A) does not exceed one-half the maximum spacing allowed between sprinklers.

Positioning Residential Pendent Sprinklers - Obstructions Along Walls



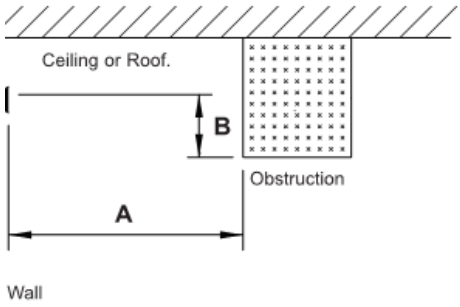
(A) Distance from centerline of sprinkler to side of obstruction.
(B) Distance from deflector to bottom of obstruction.
(C) Width of the obstruction.

Obstructions up to 30 in. (.8 m) wide (C) located against the wall are permitted to be protected when (A) is greater than or equal to (C) minus 8 in. (.2 m) plus (B).

$C \leq 30$ in. $\quad A \geq (C - 8 \text{ in.}) + B$

for metric $C \leq .8$ m $\quad A \geq (C - .2 \text{ m}) + B$

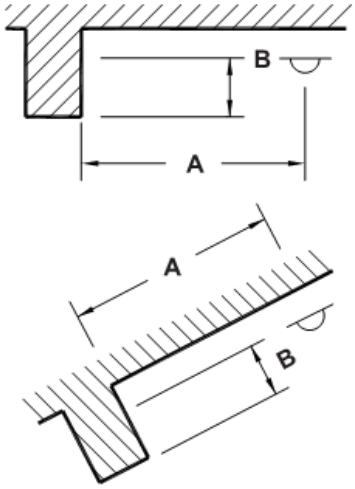
Positioning Residential Horizontal Sidewall Sprinklers - Obstructions at the Ceiling



(A) Distance from sprinkler to side of obstruction.
(B) Distance from deflector to bottom of obstruction.

Distance from Sprinkler to Side of Ceiling Obstruction (Dimension A)	Maximum Distance from Deflector to Bottom of Ceiling Obstruction (Dimension B)	
	Inches	mm
Less than 8 ft. (Less than 2.4 m)	No Obstructions Allowed	
8 ft. to less than 10 ft. (2.4 m to less than 3.05 m)	1	25.4
10 ft. to less than 11 ft. (3.05 m to less than 3.35 m)	2	50.8
11 ft. to less than 12 ft. (3.35 m to less than 3.7 m)	3	76
12 ft. to less than 13 ft. (3.7 m to less than 4 m)	4	102
13 ft. to less than 14 ft. (4 m to less than 4.3 m)	6	152
14 ft. to less than 15 ft. (4.3 m to less than 4.6 m)	7	178
15 ft. to less than 16 ft. (4.6 m to less than 4.9 m)	9	229
16 ft. to less than 17 ft. (4.9 m to less than 5.2 m)	11	279
17 ft. or greater (5.2 m or greater)	14	356

Positioning Residential Horizontal Sidewall Sprinklers - Obstructions Along Walls



Distance from Sprinkler to Side of Obstruction Along Wall (Dimension A)	Maximum Distance from Deflector to Bottom of Obstruction (Dimension B)	
	Inches	mm
Less than 1 ft. 6 in. (Less than 457 mm)	0	0
1 ft. 6 in. to less than 3 ft. (457 mm to less than .94 m)	1	25.4
3 ft. to less than 4 ft. (.91 m to less than 1.2 m)	3	76
4 ft. to less than 4 ft. 6 in. (1.2 m to less than 1.37 m)	5	127
4 ft. 6 in. to less than 6 ft. (1.37 m to less than 1.8 m)	7	178
6 ft. to less than 6 ft. 6 in. (1.8 m to less than 2 m)	9	229
6 ft. 6 in. to less than 7 ft. (2 m to less than 2.1 m)	11	279
7 ft. or greater (2.1 m or greater)	14	356

(A) Distance from sprinkler to side of obstruction.
(B) Distance from deflector to bottom of obstruction.

D. Installation Control Valve:

a. Installation Control Valve for sprinkler system shall consist of a vertical alarm valve complete with 50mm dia. drain and 15mm test valve with a provision to install water operated turbine alarm.
b. A Cast Iron Butterfly Valves shall be provided on upstream of alarm valve.
c. The Butterfly Valve shall be strictly as mentioned above. The size of alarm valve and butterfly valve shall be as indicated in BOQ,& drawings.
d. One water operated turbine alarm motor with gong shall be provided for each sprinkler installation control valve on the sprinkler main.
e. The alarm shall operate and sound a gong on the drop of pressure and flow of water in the mains.
f. Turbine alarm shall be approved by the Employer's Representative and installed at approved locations. The alarm shall be provided with suitable test cock. Both alarm valve and turbine alarm must have CFO/UL/FM approval/ listing.
g. Installation control valve shall be measured by numbers and shall include upstream C.I. Butterfly Valve, Alarm Valve, Alarm Motor and Gong, Drain Valve, Test Valve, Drain Piping and all fittings including 2 Nos. pressure gauges required to complete the work.

h. Please refer the scheme as description sheet, BOQ, for the pressure rating.

a. Alarm Valve is a double seated clapper check valve with grooved seat design, which ensures positive water flow for alarm operation and is designed for installation in wet pipe sprinkler system.
b. External bypass prevents false alarm under all supply pressure condition. In the event of variable pressure condition, false alarms are prevented with the provision of retard chamber, thus the design allows for installation under both variable and constant supply pressure condition.
c. The valve shall have Housing of Cast Iron, Seat of Bronze, Clapper of Bronze, Seat of Neoprene rubber.
d. Following specification is expected:

i. Maximum service pressure: To suit the system working pressure.
ii. Threaded opening: NPT
iii. Mounting: vertical
iv. Flange connection: IS:1538 to with stand the syatem pressure and pressure tests
v. Factory hydrostatic test pressure: 1.5 times the system working pressure.

e. PN rating shall be as per the schematic, system pressure etc

E. Inspection And Test Valve Assembly/ Zone/Floor control valve assembly/

a. Inspection and testing of the automatic starting of the sprinkler system shall be done by providing an assembly consisting of butterfly valves with supervisory switch, Orifice plate, Flow switch (to be interfaced with fire alarm system) , pressure guage with isolation valve, gunmetal sight glass, bye-pass valve , union with orifice assembly as per approved drawing. Test line shall be 25mm dia and drain shall be of 50mm dia.

b. Vane type water flow detectors shall be installed on system piping as designed on drawing / or as specified herein.
c. Detectors shall mount on any clear pipe span of the appropriate nominal size, either vertical up flow or horizontal run, at least 6'' from any fitting which may change water direction, flow rate or pipe diameter or no closer than 24'' from valve or drain.
d. Detectors shall have sensitivity in the range of 4 to 10 gallons per minute & static pressure rating of 31 bars for 2'' to 8'' pipes.
e. Detector shall respond to water flow in the specified direction after a present time delay which is field adjustable.
f. The delay mechanism shall be sealed mechanical pneumatic unit with visual indication of actuation.
g. The actuation mechanism shall include a polythene vane inserted through a hole in the pipe & connected by mechanical linkage to the delay mechanism.
h. Output shall consist of dual SPDT switches (Form C contacts).
i. Two conduit entrances for standard fitting of commonly used electrical conduit shall be provided on the detectors.
j. A grounding provision is provided. Unless noted enclosures shall be NEMA 4 listed by Underwriters Laboratories Inc. for Indoor or outdoor use.

F. Pipes For Drainage:

a. Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possible all pipes shall be arranged to drain to the installation drain valve as shown in the drawing for ordinary hazard system.
b. In the case of basement & other areas where sprinkler pipe-work is below the installation drain valve & in other trapped points in the system, Gate valves of the 50 mm dia shall be provided.

G. Pressure reducing Station

a. PRV shall be complete with station with isolation valve, pressure gauge before after PRV along with bypass line. The by pass line to be provided with isolation valve.
b. Valves shall maintain a constant downstream pressure regardless of fluctuations in demand and shall also prevent a pressure rise when demand is zero. Valve shall be suitable for horizontal or vertical installation.

c. No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of Ductile iron. Ductile Iron is standard and other materials shall be available.
d. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-Section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.
e. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of Sufficient diameter to withstand high hydraulic pressures, shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.
f. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.
g. The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 6" and smaller size valves shall be threaded into the cover and body. Valve seat in 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including cast material shall be of approved manufacture.
h. The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.
i. The valve manufacturer shall be able to supply a complete line of equipment from 1 1/4" through 24" sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a computerized cavitations chart which show flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitations damage.
j. Valves shall be single-seated, hydraulically - operated. Valve body and cover shall be Ductile IronClass 150/Class 300, flanged. Trim shall be bronze. Valve seat shall be replaceable. There shall be no external packing glands.
k. Valves shall have integral low flow by-pass line.
l. Main valve and all trim shall be factory- assembled into one unit.

H. PRESSURE SWITCH

The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. The housing shall be die cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable.

The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP:55 water and environment protection.

4.2 Execution

A. Scope of work under this section comprises of furnishing all equipment, appliances, material, and labour necessary and required to install Automatic Sprinkler System as required by the drawings, specified herein or as given in the bill of quantities.
B. Without restricting to the generality of foregoing, the sprinkler system shall include the following:
   a. Galvanized iron Class C (heavy class) main sprinkler distribution piping complete with welded, forged steel fittings, grooved, flanges, supports, hangers all required accessories and appurtenances.
   b. Installation control valves ,drain valve, test valve,flow switch,drain assembly,drain piping.orifice plates and all connecting pipes and fittings.
   c. Sprinkler heads, nozzles and spare sprinklers.
   d. Connections to risers, pumps and appliances.
   e. Sprinklers Pump, Jockey Pump, Booster pump Motors, Control Panels, Air Vessels, Cabling, Instruments and accessories, as specified.
   f. Sprinkler Lines for each floor shall be left with complete sprinkler drain arrangement with blanked flange.
C. No jute will be allowed in threaded joints.
D. Header piping if lmore than 50mm t, shoe joints is to be provided.

4.3 Testing and Commissioning

A. Start the sprinkler pump and develop the required pressure in the sprinkler pipes.
B. Open the test valve to test the automatic starting of the pump. If necessary, make necessary adjustments in the setting of pressure switch. The sprinkler water gong alarm shall also operate when the test valve is open. This operation is to be done for each and every section of the sprinkler system and the alarm for each section (via flow switch) shall be checked for operation.
C. After satisfactory operation of the pump the Contractor shall set up mock fire and test the system.
D. Physical examination of pipe joints, connection of valves, sprinklers, orifice plates etc.

5. Clean Agent Fire Suppression System for Main LV Rooms:

5.1 General

Comply with General Requirements and all documents referred to therein. Provide all labor, materials, products, equipment and services to supply and install a gaseous fire suppression system as required & indicated on the Drawings and specified in this Section of the Specification in accordance with NFPA 2001 and to the requirements of the CFO.

This installation shall be made in strict accordance with the drawings, specifications and applicable National Fire Protection Association Standards. All equipment and devices used shall be listed in both the UL Fire Equipment List and the Factory Mutual Approval Guide.

Design and installation of the fire detection/inert gas suppression system will be in strict accordance with the following guidelines and regulatory agencies:

NFPA 2001 Clean Agent Fire Extinguishing Systems & NFPA Standards 70, 72A, 72B, 72C & D

Perform all tests and provide certification as required by authorities having jurisdiction. Provide comprehensive shop drawings to the approval of the CFO. Furnish all engineering design and materials, for a complete fire detection/inert gas suppression system, including charged inert gas storage containers, nozzles, control panel, detectors, wiring, annunciators, alarm and any and all other equipment necessary for a complete operational system.

Major system components shall be produced by the approved ISO 9002 certified equipment supplier and shall be installed by a specialist contractor authorized by the approved equipment supplier.

Contractor shall, as a minimum, provide 24-hour emergency service, 7 days a week and shall be able to respond to an emergency situation within 2 hours of receiving an emergency trouble call.

5.2 System Description and Operation

A. The system shall be a total flooding Clean Agent gas extinguishing system designed to provide a uniform concentration of 7.0% clean agent gas for the protected area.

B. The amount of Clean Agent gas to be provided shall be the amount required to obtain a uniform 7.0% (minimum) concentration for ten (10) minutes. Take into consideration such factors as un-closable openings (if any), “rundown” time of fans, time required for dampers to close (and requirements for any additional dampers), and any other feature of the facility that could affect concentration. The design concentration, however, shall be 7.0% (minimum) by volume at 21° C.

C. Cross-zoned or Verified Smoke Detection: The Clean Agent gas system shall be automatically actuated by either verified detection circuits or cross-zoned detection circuits. Smoke detectors shall be of the ionization and photoelectric types installed at no more than 23 square meters of coverage per detector (or as per manufacturer’s / applicable standards requirements). The detectors shall be alternated throughout the protected area and be compatible on either circuit.

5.3 Alarm and Discharge Action

D. Phase I (General Alarm)

Activation of any single detector in any detection zone shall:
a) Cause a first-stage alarm (slow pulse horn/strobe).
b) Energize a lamp on the activated detector and control panel.

E. Phase II (Pre-Discharge)

Activation of two adjoining (cross-zoned) or any second (verified) detector shall:
a) Transmit an alarm signal to remote monitoring or building alarm panel
b) Cause a second-stage (pre-discharge) alarm (fast pulse horn/strobe) to operate.
c) Operate auxiliary contacts for air conditioning shutdowns and automatic dampers.
d) Initiate an adjustable time delay (Clean Agent gas release).

F. Phase III (Discharge)

Upon completion of the time delay the Clean Agent gas system shall:

a) Cause discharge (steady horn/strobe) alarm to be activated.
b) Operate auxiliary contacts for emergency power off all electrical equipment (excluding lighting and emergency circuits for life safety).
c) Activate visual alarms at protected area entrance (strobe).
d) Energize control solenoid for Clean Agent gas cylinders releasing gaseous agent into the alarmed zone only.

5.4 Auxiliary Components

A. Manual Releasing Stations shall be provided at each exit of the protected area and shall when activated, immediately release the inert gas and cause all audible/visual alarms to activate. In addition, activation of the Manual Releasing stations shall cause immediate shutdown of air and power circuits.

B. Abort Stations shall be provided at each exit of the protected area and shall, when operated, interrupt the discharge of inert gas and emergency power off function. The Abort Stations shall be momentary devices (dead-man) requiring constant pressure to maintain contact closure. Note: Manual Pull Station activation shall override any abort Station. Abort Station operation shall be per IRI and FM guidelines.

C. Graphic Annunciator shall be provided at the control panel location. The Graphic Annunciator shall be provided by the equipment manufacturer in an approved NEMA enclosure with keyed face plate. The Graphic Annunciator shall display the entire inert gas protected area (silk screened) and shall indicate each smoke detector and its proximity.

D. Smoke detectors, when activated, will individually annunciate at the graphic Annunciator as follows:
a) Ceiling Detector: Red LED
b) Subfloor Detector: Amber LED

5.5 Materials and Equipment – Electrical

A. Materials and equipment shall be of a single manufacturer. Provide materials and equipment from approved suppliers. The name of the manufacturer and the serial numbers shall appear on all major components. Locks for all cabinets shall be keyed alike.

B. All electrical enclosures, trunking and conduits shall be employed in accordance with applicable codes and intended use and contain only those electrical circuits associated with the fire detection and control system and shall not contain any circuit that is unrelated to the system.

C. 3. Unless specifically provided otherwise in each case, all conductors shall be enclosed in steel conduit, rigid or thin wall as conditions dictate.

D. Any conduit or trunking exposed to weather or other similar conditions shall be properly sealed and installed to prevent damage, provisions for draining and/or drying shall be employed.

E. NEMA rating and/or electrically hazardous classifications shall be observed and any equipment or materials installed must meet or exceed the requirements of service.

F. Any wiring shall be of the proper size to conduct the circuit current but shall not be smaller than 18 AWG, unless otherwise specified for a given purpose. Wire that has scrapes, nicks, gouges or crushed insulation shall not be used. The use of aluminum wire is strictly prohibited.

G. Wire splices shall not be made.

H. All wire terminations shall be made with crimp terminals unless the device at the termination is designed for bare wire terminations.

I. All electrical circuits shall be numerically tagged with suitable devices at its terminating point

J. All circuit numbers shall correspond with the installation drawings.

K. The use of colored wires is encouraged but not required unless dictated by state or local authorities.

L. Black colored wire shall be used exclusively for the identification of the neutral conductor of an alternating current circuit.

M. Green/Yellow colored wire shall be used exclusively for the identification of the earth ground conductor of an AC or DC circuit.

N. 13. Primary system voltage shall be 220 VAC, single phase, 50 Hz.

5.6 Control Systems – General

All control systems shall be UL listed or FM approved and be utilised with listed or approved operating devices and shall be capable of the following features:

A. Ground fault indication.
B. Supervised detection circuit(s).
C. Supervised alarm circuit
D. Supervised release circuit
E. Supervised manual pull circuit
F. Supervised line power circuit
G. Alarm overrides trouble logic.
H. Battery standby.
I. Front panel indicating lamps (LEDs).
J. Key lock steel enclosure.
K. Programmable time delay.
L. Programmable detection logic.
M. Prioritized trouble logic.
N. Solid state integrated circuitry.
O. Lamp test.

5.7 Equipment and Materials (Mechanical)

A. Pipe Material – Clean Agent Gas System

a) Clean Agent gas system piping shall be of non-combustible materials having physical and chemical characteristics such that its integrity under stress can be predicted with reliability.
b) As a minimum, piping materials shall be black steel pipe conforming to ASTM A- 106A SMLS or ASTM A53A.
c) Under no conditions shall ordinary cast iron pipe, steel pipe conforming to ASTM A-120 or ASTM A53/A-120 be used.
d) Clean Agent gas piping joints shall be suitable for the design conditions and shall be selected with consideration of joint tightness and mechanical strength.
e) As a minimum fittings beyond the orifice union shall be black, 136 Kg (300 lb.) class fittings conforming to ANSI B-16.3. Ordinary cast iron fittings shall not be used.
f) The system manifold up to the orifice union must be constructed of Schedule 80 piping and 907 or 1360kg forged steel fittings. Distribution piping down stream from the orifice union must be constructed of a minimum of Schedule 40 piping and 136kg fittings.
g) All piping shall comply with NFPA-2001.
h) Piping shall be installed in accordance with good commercial practice to the appropriate codes, securely supported with UL Listed hangers and arranged with close attention to the design layout since deviations may alter the design flow performance as calculated.
i) Piping shall be bracketed within 300 mm of all nozzles.
j) All piping must be reamed, blown clear and swabbed with appropriate solvent to remove mill varnish and cutting oils before assembly.
k) Multi-outlet fittings other than tees shall not be permitted.
l) Assembly of all joints shall conform to the appropriate standards. Threaded pipe joints shall utilize Teflon tape applied to the male threads only.

B. Agent

The agent shall be any one of Clean Agent Gas HFC 227 / IG 541 / CO2.

C. Clean Agent Gas Storage Cylinders

a) Clean Agent gas cylinder assemblies shall be steel constructed with a standard RED epoxy paint finish. Each cylinder shall be equipped with a pressure seat type valve and gauge.

b) The system shall utilize approved pilot valve assemblies. Each valve shall be constructed of forged brass and shall attach to the cylinder providing a leak tight seal. Each valve shall also include a safety pressure relief device that provides relief as per CGA test methods.

c) The size of all cylinders shall be based on computer verified system design requirements.

D. Tank Bracket

Each Clean Agent gas tank shall be furnished with a bracket made from welded steel. The bracket shall hold the cylinders in a saddle and have a front bracket piece that holds the cylinders in place. The brackets shall have the ability to add more bracketing or stack cylinders depending on installation requirements.

Brackets shall be UL/FM Listed for use with Clean Agent gas Systems.

E. Valve Actuators

a) Clean Agent gas valve actuators shall be of brass construction, stackable design, with swivel connections to allow removal of actuators for maintenance or testing.

b) Operation of actuators shall not require replacement of components. NO ELECTRO-EXPLOSIVE DEVICES may be used to actuate the valve assembly.

c) Electric actuators shall be of the magnetic latch type or of the continuous duty type for 24 VDC operations. UL/FM Listed for use with Clean Agent gas.

F. Discharge Hose / Check Valve

a) When manifolding, all tank assemblies shall include a flexible discharge hose and check valve for connection to the manifold inlet.

b) All hose/check valves shall be UL Listed or FM approved for use with the high flow Clean Agent gas valve.

G. Discharge Nozzles

a) Clean Agent gas discharge nozzles shall be of two piece construction sized to provide flow rates in accordance with system design flow calculations.

b) b) A nozzle inlet orifice plate shall be included. The orifice size shall be determined by a computerized UL Listed, FM Approved flow calculation programme.

c) c) Orifice shall be machined in the nozzle body to provide a horizontal discharge pattern based upon the approved coverage arrangements.

d) Nozzles shall be permanently marked with the manufacturer's part number. The nozzle shall be threaded directly to the discharge piping without the use of special adapters.

e) Nozzles shall be UL Listed, FM Approved.

H. Orifice Union / Nipple Assembly

a) A manifold orifice union shall be included to reduce pressures in the downstream piping.

b) A nozzle inlet orifice plate shall be included. The orifice size shall be determined by a computerized UL Listed, FM Approved flow calculation programme.

c) Orifice shall be machined in the nozzle body to provide a horizontal discharge pattern based upon the approved coverage arrangements.

I. System Checkout and Testing

a) The completed installation shall be inspected by factory authorized personnel and shall include a full operational text of all components per the equipment manufacturer recommendations (including agent discharge).

b) This shall be done in the presence of the Client representative, insuring authority, and the Local Civil Defense Authority.

c) All mechanical and electrical components shall be tested according to the manufacturers recommended procedure to verify system integrity.

d) An inspection shall be provided by the Contractor. Inspection shall include a complete checkout of the electronic system and certification of cylinder pressure. A written report shall be filed with the Company.

e) As-built drawing shall be provided by the Contractor (6 copies) indicating the installed details. All routing of piping and electrical conduit and accessories shall be noted.

f) Equipment, installation and maintenance manuals shall be provided in addition to the as-built drawings.

g) Prior to final acceptance, the Contractor shall provide operational training in all concepts of the system to the Company's key personnel. Training shall consist of:

i. Control system operation.
ii. Trouble procedures.
iii. Abort procedures.
iv. Emergency Procedures.
v. Safety requirements.
vi. Demonstration of the system (excluding Clean Agent gas release).
vii. The quantity of agent shall reflect the actual design quantity of Clean Agent.

h) A functional test shall be completed prior to the concentration test consisting of detection, release, alarm, accessories related to the system, control unit and a review of the tanks, piping, fittings, hangers and cylinder pressure.

i) Concentration test shall be provided under the supervision of the Contractor's authorized personnel in the presence of the Client representative, local authorities and any other insuring authority.

j) Clean Agent gas test procedures shall be recommended by the equipment manufacturer and the Clean Agent gas supplier.

k) The Contractor shall provide a gas analyzer capable of automatically recording sampling points. Concentration recording shall continue until authorities are satisfied with hazard integrity or 10 minutes have elapsed.

l) The sampling points shall be located at strategic areas but no higher than the highest combustible contents.

m) If the test results indicate that the design concentration was not achieved and/or held, the Contractor shall determine the cause of the failure. After determination of the cause, the system shall be recharged and again placed in operation. The Contractor shall only be responsible for retest based on equipment design/failure.

J. Control Panel

a) Provide a control system, in addition to the general requirements for control panels, the control system shall meet the requirements of this section.

b) The control system shall consist of a power supply, programmable zone actuation with the necessary number of supervised circuits and auxiliary relays.

c) The Internal power supply shall operate from 220 VAC, single phase, 50 Hz (1.0/0.5 amp rectified to 24 VDC (2 amp).

d) d) The control system shall provide provisions for housing its own set of "on-line" float charge emergency batteries within the enclosure.

e) The control system shall provide two supervised detection (input circuits) programmable for:

i. Independent-zoning.
ii. Priority-zoning.
iii. Cross-zoning

f) A supervised dedicated manual pull circuit designated for immediate operation of the release circuit shall be provided.

g) Abort function (if used) shall be programmed for either immediate release or 10 second delay after abort and comply with IRI requirements.

h) A programmable time delay for 10, 15, 30 or 60 seconds shall be provided between verification of a fire situation and suppression system release.

i. Battery Supervision shall be provided for condition and placement of the batteries.

ii. Four (4) plug-in relays with two (2) Form C (DPDT) contacts, one relay with Form C (SPDT) rated at 10 amps, 30 VDC and 7.5 amps at 240 VAC shall be provided for auxiliary functions. Each of the following actions shall cause one for the five relays to transfer:

- General alarm.
- Pre-discharge alarm.
- System discharge.
- Assignable general alarm or pre-discharge alarm.
- System trouble.

i) LED indicators shall be provided on the front door to annunciate the following conditions:

i. Power On (green)
ii. System trouble - (yellow)
iii. Zone 1 alarm - (red) (yellow)
iv. Zone 2 alarm - (Red) (Yellow)
v. Manual pull/Abort alarm - (Red) (Yellow)
vi. General alarm - (Red) (Yellow)
vii. Pre-discharge alarm - (Red) (Yellow)
viii. System fired - (Red) (Yellow)

j) Prevent Switch. Furnish each zone with a keyed on/off switch in the face of the control panel to prevent automatic actuation of the system. In the off mode only operation of the manual pull stations will cause discharge.

k) Smoke Detector - Photoelectric

Refer to Electrical Specification.

l) Horns & Strobes

Refer to Electrical Specification.

m) Manual Call Points

Refer to Electrical Specification.

n) Abort switch

i. The abort switch shall be used where delay is desired between detection and actuation of the fire suppression system.

ii. This switch shall be a momentary contact “dead-man” type switch requiring constant pressure to transfer one set of normally open contacts. Clear operating instructions shall be provided at the abort switch.

iii. iii) This switch shall be rated at 6 amps at 240 VAC and 1.1 amps at 240 VDC.

iv. iv) The terminal connections shall be of the screw type.

5.8 CLEAN AGENT Gas System Arrangement

A. Clean Agent gas fire suppression system shall be of the engineered, permanently piped, fixed nozzle type.

B. All agent storage containers shall be centrally located as vertical, free-standing cylinders with wall mounted or floor mounted retaining brackets. Where multiple cylinders are required for the same hazard, a common manifold shall be employed.

C. Computerized verification of flow calculations shall be submitted for each inert gas system and include the following data as a minimum:

a) Quantity of agent per nozzle.
b) Type of nozzle.
c) Pressure at nozzle (KPa).
d) Nozzle body nominal pipe size (mm).
e) Number and size of tanks.
f) Total agent.
g) Pipe size per pipe section.
h) Pipe schedule per pipe section.
i) Number, size and type of fitting per pipe section.
j) Actual length per pipe section (meters).
k) Equivalent length per pipe section (meters).
l) Discharge time (seconds).
m) Pressure available at the start and end of each pipe section (KPa).
n) Flow rate per pipe section (l/s).

5.9 Testing & Commissioning

A. Perform testing & commissioning in accordance with NFPA 2001 and to the requirements of the Authority of Jurisdiction.

B. Provide services for manufacturer's representative for start up and to demonstrate and train owner's representative.

C. Train owner's maintenance personnel on procedures and schedules related to start up, shutdown, troubleshooting, servicing and preventive maintenance.

D. Submit all maintenance manuals / catalogues of installed equipment's.

5.10 Warranty

A. All Clean Agent gas system components furnished under this contract shall be guaranteed against defect in design, material and workmanship for the full warranty time which is standard with the manufacturer and/or supplier but not less than two (2) year from the date of system acceptance.

B. In addition, the installing Contractor must guarantee the system against false actuation or leakage due to faulty equipment, design or workmanship for a period of two (2) year from final acceptance.

C. In the event of Clean Agent gas leakage or system discharge from any of the above conditions, the installing Contractor shall completely recharge and recondition the system at no cost to the Comp

6. Drencher System (refer mail)

6.1 Scope

A. Scope of work under this section comprises of furnishing all equipment, appliances, material, labour necessary and required to install drencher system on fire check floor as per CFO's requirements and as specified in the drawings, Bill of quantity and Specifications. The contractor shall make sure to supply all the necessary parts ,accessories and controls to make the system functional
B. The System description in brief can be described as follows

   a. The main drencher pipe will be tapped off at fire check level from the main sprinkler riser after the tapping from the pipe will be connected to deluge valve assembly. The drencher pipe will be run through the periphery of the fire check floor and drenchers will be installed across the periphery of the fire check floor.
   b. The Drencher system / deluge valve assembly will be connected to fire alarm system and fire control panel.
   c. In event of fire the drencher floor/system will get activated through deluge valve assembly and separate the upper and floor portion of building at fire check level through water curtain hence preventing fire pass across the fire check floor.
   d. There shall be a manual emergency release system in case of failure of automated system in deluge valve assembly.
   e. Six monthly quality checks will be carried out to ensure completely clean, corrosion free system without any blockage of drencher in event of fire.

C. Without restricting to the generality of foregoing, the drencher system shall include the following:

   a. Galvanized iron Class C (heavy class)/ERW main distribution piping complete with welded, forged steel fittings, flanges, supports, hangers all required accessories and appurtenances.
   b. Installation control valves, Deluge valves electrically activated , electrical trim , drain valve, test valve and all connecting pipes and fittings.
   c. Water curtain nozzles heads and spare nozzles, manual release system.
   d. Connections to risers, pumps and appliances
   e. Control Panels, cabling, instruments and accessories as specified.

D. General Requirements:

   a. Pipes and fittings shall be the same as for Fire sprinkler System.
   b. Jointing shall be the same as for Fire sprinkler System.
   c. Valves shall be the same as for Fire sprinkler System.
E. System Brief-

Drencher/Water curtain system shall be designed to provide protection for vertical openings, to separate an area of high fire risk such as car park, for exposure protection, and to provide protection for refuge and fire check floors to meet local fire authority approval.

Drencher/Water curtain system shall be designed to provide a minimum flow of 56.8 lpm at 0.50 kg/cm2 pressure to the farthest and hydraulically remotest nozzle.

The pump flow shall be designed on the basis of flow required for the largest zone. This shall be checked and verified both by hydraulic calculation and on site verification.

Deluge valve shall be UL listed and FM approved Ductile Iron body conforming to relevant ASTM standards. The system designed shall comply with the local fire authority code of standard. Drencher/Water curtain system shall be actuated by an automatic detection system. A manual release with operating instruction shall be supplied and installed near the deluge valve. Where the drencher/water curtain system is used to separate an area of high risk for life safety protection or to protect a compartment forming part of an escape route as indicated or where specified, the drencher system shall be actuated by smoke detection system. Detectors shall be arranged in cross zone operation. The detectors shall be arranged each on either side of the drencher heads. The activation of one detector shall energize an alarm with audio and visual indication on the control panel. The activation of any two detectors arranged in coincidence connection shall operate the

drencher installation. Where required by local fire authority and approved by the Architect, activation of the detectors provided solely for the drencher system shall not energize the general fire alarm and shall not send the fire signal via the fire alarm direct link and alarm transmitter.

The drencher head shall be designed to provide a flat 180 degree fan-shaped spray pattern to protect the vertical surface. Drencher head to be UL and FM approved with minimum operating pressure of 7 Psi (0.50 kg/cm2). Drencher head body to be of Brass UNS-C36000 construction.

Contractor shall calculate the number of drencher heads, select the types of drencher heads and arrangement to provide an even flow of water over the entire vertical surface of the openings protected by the drencher system. Contractor shall consider the effect of wind and air movement in surrounding environment of the protected area in the design and selection of equipment for drencher system.

Contractor shall submit the network analysis & Pump head calculation with the help of standard approved software and decide optimum head for fire fighting pumps for Drencher system.

a. Contractor shall check and verify the sizing of pipework by hydraulic calculation and submit fully calculated results to the local consultant for approval. Contractor shall calculate and check size of water storage tank which shall be adequate for not less than an hour of operation of all drencher installations that are required to be operated simultaneously.

6.2 Nozzle Heads (To be checked for availability of FM/UL Listed)

A. Nozzle heads shall be provided at appropriate spacing as per the approved material submittal. Spacing shall be in conformity with the drawings and properly co-coordinated with façade elements. Detailed shop drawings for system shall be prepared by Contractor and submitted to Owner/ Architect/ Consultant for approval before starting the work.
B. Nozzle heads shall be of gunmetal/ brass /Stainless Steel curtain nozzle type with deflector. Head shall be of type and make approved by the Consultant. The inlet shall be screwed dia. The Nozzle head shall have UL/ FM approval or listing.
C. Contractor shall supply spare heads as per standards and one spanner (not separately payable), neatly installed in a M.S cabinet with glass shutters as approved by the Owner/ Architect/ Consultant.

6.3 Deluge Valve Assembly

A. Deluge valve shall utilize a 90°/180° pattern type of deluge valve. Deluge valve shall be externally reset table by hydraulic means and mechanical.
B. Deluge valve shall employ a pressure operated relief valve-venting device on the priming line to ensure that the deluge valve will not prematurely reset. Inlet and outlet connections of deluge valve will be pipe thread (female)/ flanged connection.
C. Deluge valve shall be UL Listed or Factory Mutual Approved with a ductile/ Cast iron body. Deluge valve shall be selected at 1.5 times of the working pressure or minimum 16 bar whichever is higher. Valve trim shall be coated, compatible and shall be installed following the manufacturer's specifications. The equivalent friction loss for deluge valve shall be no greater than 18'-0" equivalent feet of 2" Schedule 40 steel pipe.
D. The basic trim required shall contain the following components which are required in all types of installation, such as the main drain valve, priming connection, drip check valve, emergency release valve and pressure gauges.
E. Deluge valve to have orifice plate

6.4 Electric Release Trip

To actuate a deluge valve electrically, a solenoid valve is provided to drain the water from the top chamber of the deluge valve. A pressure switch is provided to activate an electric alarm, to shut down the desired equipment or to give "Tripped" indication to the panel. In addition to this two nos of pressure switches can be used to monitor "Low air pressure" and "Fire condition" when used in dry pilot airline. The trim assembly shall be complete with Isolation valve, Diaphragm Supply valve, Manual control station , Automatic Shut-off valve, Automatic drain valve, pressure switch, Water Motor gong ,Releasing panel, Solenoid valve.

6.5 Supports shall be the same as in for Fire Hydrant / Sprinkler System.

Please refer to chapter 10

7. FIRE PUMPS & ANCILLARIES

7.1 Material

A. **Scope**

Scope of work under this section comprises of furnishing all equipment, appliance, material, labour necessary and required to completely install electrically operated centrifugal pumping sets and a diesel engine driven pump set for Fire Hydrant and Sprinkler installation as required by the drawings and specified hereinafter or given in the bill of quantities. Without restricting to the generality of the foregoing the pumps and ancillary equipments shall include the following:

a. Electrically / diesel (as per CFO) operated End suction/ horizontal split case centrifugal pumps/ main fire pumps, Sprinkler, jockey and booster pumps with motor, base frames, flexible couplings and all accessories as specified.
b. Installation control valve
c. Expansion Tank
d. All materials & equipments used shall be UL /FM listed or TAC/IS approved as mentioned in the drawings.
e. Air separators/ Air release valve
f. Pressure switches, pressure gauges, pump control valves, test valves, drains, exhausts air vessels etc.
g. Electrical control panel with necessary logic built in, all cabling, wiring, and annunciation system, earthing etc.
h. Automatic starting system with all accessories, wiring and connections and pressure switches.
i. Motor control centre.
j. Pressure gauges with isolation valves and piping bleed and block valves.
k. Suction strainers, Valves, N.R.V, water meter and accessories.
l. Flexible connections
m. Vibration eliminator pads and foundation bolts.
n. Leak-off shall be led to the nearest floor drain.
o. Eccentric reducer
p. Pressure relief valve

B. General Requirements

a. All pumps used shall be UL/FM listed or TAC and IS approved as mentioned in the drawings & BOQ**.**
b. All pumps shall be installed true to level on suitable concrete foundations. Base frames shall rest on vibration isolation mountings/inertia base as specified, to avoid vibrations.
c. Pumps and motors /diesel engine shall be truly aligned to the satisfaction of Owner/ Architect/Employer's Representative. Record of such alignment shall be furnished to the Project Manager.
d. All pump connections shall be of Indian Standard flange type with appropriate number of bolts as per relevant standard requirement for the working pressure. Companion flanges shall be provided with the pumps.. Manufacturers' instructions regarding installation, connections and commissioning shall be followed with respect to all pumps, switchgears and other accessories.
e. Pumps shall be designed for continuous operation and shall have a continuously dropping head characteristic without any zone of instability. Power capacity characteristic shall be no overloading type. Head vs. capacity, input power vs. capacity characteristics, etc., shall match to ensure load sharing and trouble free operation throughout the range. In case of accidental reverse flow through the pump the driver shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed. Contractor under this specification shall assume full responsibility in the operation of the pump and the drive as one unit.
f. Automatic air release valve shall be provided to vent air from the pump discharge and also to admit to the pump to dissipate the vacuum there, upon stopping of the pump.
g. Pump coupled with motor or engine on a common base plate shall perform smoothly without any excessive noise or vibration. Also pump shall be provided with re-circulation piping with valves.
h. All pumps shall have the impeller size chosen to maximum of 80% of the largest size that can be accommodated in the casing.

i. The following inter-locking between the two main fire pumps (i.e. wet riser pump & sprinkler pump), the jockey pump and the diesel engine driven pump. Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser and sprinkler, both the wet riser and sprinkler can come up at a time) or diesel driven pump.

j. Pump shall be capable of delivering 150% of the rated capacity at 65% of the rated head and the no-delivery head shall be not more than 140% (150% in case of end suction type) of the rated delivery head. The pump casing shall withstand 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.

	JOCKEY PUMP	WET RISER PUMP	SPRINKLER PUMP
i.	ON	OFF	OFF
ii.	OFF	ON	OFF
iii.	OFF	ON	ON
iv.	OFF	OFF	ON

k. Seismic isolation and clamping for each pump and flexible connection on the suction as well as the discharge side shall be provided.

l. The contractor shall submit with this tender a list of recommended spare parts for three years of normal operation and quote the prices for the same as a separate submittal / annexure

m. The contractor shall submit the network analysis & Pump head calculation with the help of standard approved software and decide optimum head for fire fighting pumps for Hydrant, Sprinkler & Drencher / Water Curtain system.

n. Contractor shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The contractor shall provide facilities to the Project Manager & Consultant/Client for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works before dispatching from factory without any cost to the Project Manager or Consultant/Client.

o. One solid state electronic annunciation panel, fully wired with visual display and audible alarm unit shall be provided to indicate :

i. Flow condition in any flow switch indicating the area of distress and fire alarm.
ii. Starting and stopping of each hydrant pump.
iii. Starting and stopping of each jockey pump.
iv. Starting and stopping of each sprinkler pump.
v. Failure of Hydrant / Sprinkler pumps to start.
vi. Low level in HSD day tank of the fire pump.
vii. High level in Fire water storage tank compartment.
viii. Low level in fire water storage tank compartment.
ix. Low level in HSD day tank of the fire pump.

The panel shall be factory fabricated, wired and tested. All details shall be submitted with the tender. The annunciation panel shall be located in the security office / reception on the ground floor.

C. Fire Pumping Sets :- Horizontal Split Case

a. Contractor shall provide and install electrically and /or diesel engine operated fire pumps of capacity and head indicated in the drawings/ bill of Quantities.

b. **All pumps used shall be UL/FM listed or TAC and IS approved as mentioned in the drawings & BOQ**

c. Pumps shall be horizontal split case multistage meeting the duties as specified in the bill of quantities with closed grain cast iron body, bronze impellor and stainless steel shaft. Jockey Pumps shall be Inline vertical multistage Centrifugal type.

d. Pumps shall be coupled with motor by means of flexible type coupling. Pumps shall be of type approved by NFPA and capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. Shut-off head of pumps shall not exceed 120% of the rated head.

e. Casing shall be cast iron to IS 210 and capable of withstanding 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.
f. Impeller shall be of standard bronze. Impeller shall be secured to the shaft with hydraulically balanced and shall be retained against circumferential movement by keying, pinning or lock rings. All screwed fasteners shall tighten in the direction of normal rotation.
g. Shaft size shall be selected on the basis of maximum combined shear stress. Shaft shall be of stainless steel AISI-410 ground and polished to final dimensions and shall be adequately sized to withstand all stresses from motor weight, hydraulic loads, vibrations and torque is coming in during operation. Pump Shaft-Motor Shaft Coupling shall be connected with adequately sized flexible couplings with spacer of suitable approved design. Necessary guards shall be provided for couplings. Pumps shall be with gland plate for gland packing. The gland shall be double compression and the same shall be weather & fire proof.
h. Common base plate for mounting both the pump and drive shall be provided. Base plate shall be of rigid construction, shall be fabricated by M.S. channels. Base plate and pump supports shall be so constructed, the pumping unit shall be mounted so as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc.
i. Rotating elements shall be so designed to ensure least vibration during start and throughout the operation of the equipment. All rotating components shall be statically and dynamically balanced in the Works. All the components of pumps of identical parameters supplied under these specifications shall be interchangeable.
j. Following operational logic to be followed for fire pump room operation. Contractor shall be responsible for design, supply, install, test and commission the necessary control panel to fulfill the below logic along with necessary control caballing and pressure switches

D. Fire Pumping Sets :- End Suction

a. Contractor shall provide and install electrically and /or diesel engine operated fire pumps of capacity and head indicated in the drawings/ bill of Quantities.
b. All pumps used shall be in compliance with TAC and IS with IS 3844.
c. Pumps shall be Horizontally mounted, end suction mono block pump, suitable for operation on 415 volts ± 6%, 3 phase, 50 HZ A.C supply. The motor shall conform to IS: 325 - 1978 (up date) with Flexible coupling and coupling guard, complete as required fire pump having C.I. body, bronze impeller and S.S. Shaft with mechanical seal, capable for delivering flow rate and head mentioned in CFO NOC and specified in the bill of quantities with closed grain cast iron body, bronze impellor and stainless steel shaft. .
d. Pumps shall be coupled with motor by means of flexible type coupling. Pumps shall be of type approved by NFPA and capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. Shut-off head of pumps shall not exceed 120% of the rated head.
e. Casing shall be cast iron to IS 210 and capable of withstanding 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.
f. Impeller shall be of standard bronze. Impeller shall be secured to the shaft with hydraulically balanced and shall be retained against circumferential movement by keying, pinning or lock rings. All screwed fasteners shall tighten in the direction of normal rotation.
g. Shaft size shall be selected on the basis of maximum combined shear stress. Shaft shall be of stainless steel AISI-410 ground and polished to final dimensions and shall be adequately sized to withstand all stresses from motor weight, hydraulic loads, vibrations and torque is coming in during operation. Pump Shaft-Motor Shaft Coupling shall be connected with adequately sized flexible couplings with spacer of suitable approved design. Necessary guards shall be provided for couplings. Pumps shall be with gland plate for gland packing. The gland shall be double compression and the same shall be weather & fire proof.
h. Common base plate for mounting both the pump and drive shall be provided. Base plate shall be of rigid construction, shall be fabricated by M.S. channels. Base plate and pump supports shall be so constructed, the pumping unit shall be mounted so as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc.
i. Rotating elements shall be so designed to ensure least vibration during start and throughout the operation of the equipment. All rotating components shall be statically and dynamically balanced in the Works. All the components of pumps of identical parameters supplied under these specifications shall be interchangeable.
j. Following operational logic to be followed for fire pump room operation. Contractor shall be responsible for design, supply, install, test and commission the necessary control panel to fulfill the below logic along with necessary control caballing and pressure switches.

1	Pump Description	Horizontal end suction Mono block
2	Casing	Cast Iron/Cast Steel
3	Impeller	Bronze
4	Shaft	High Tensile Steel
5	Bearings	Heavy duty Ball/Roller Bearings
6	Base Plate	Cast Iron/Fabricated M.S.
7	Flanges	Conforming to ISS 1536/1960
8	Packing	Mechanical Seal
9	Max.Speed	2900 RPM

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10	Starter	DOL / STAR DELTA
11	Motor	IP65
12	Panel	Suitable for outdoor installation –IP65

E. **Diesel Fire Pump -**

F. **General**

The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common base plate.

Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500 RPM as specified.

Fire Pump

The fire pump shall be horizontally mounted centrifugal single/ multi stage, single/ multi outlet. It shall have a capacity to deliver as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be single/ multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made.

The pump casing shall be designed to withstand 1.5 times the working pressure.

Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

Diesel Engine

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycle, aircooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

Engine Accessories - The engine shall be complete with the following accessories:-

Fly wheel dynamically balanced.
Direct coupling for pump and coupling guard.
Corrosion Resistor.
Air cleaner.
Fuel service tank support, and fuel oil filter with necessary pipe work.
Elect. starting battery (2X24 v).
Exhaust silencer with necessary pipe work.
Governor.

Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).

Necessary safety controls.

Fuel System - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 4 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediments into the fuel line to the engine.

As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of supply.

Lubricating Oil System- Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

Starting System- The starting system shall comprise necessary batteries (2x24v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The capacity of the battery shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

Exhaust System - The exhaust system shall be complete with silencer suitable for outdoor installation and silencer piping including bends and accessories needed for a run of 15 metre from the engine manifold.(Adjustment rates for extra lengths shall also be given). The total back pressure shall not exceed the engine manufacture's recommendation. The exhaust piping shall be suitably supported.

Engine shut down mechanism- This shall be auto/ manually operated and shall return automatically to the starting position after use.

Governing System- The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

Engine Instrumentation- Engine instrumentation shall include the following:-

i) Lub. oil pressure gauge.
ii) Lub. oil temperature gauge.
iii) Water pressure gauge.
iv) Water temperature gauge.
v) Tachometer.
vi) Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

Engine Protection Devices- Following engine protection and automatic shut down facilities shall be provided:-

i) Low lub.oil pressure.
ii) High cooling water temp.
iii) High lub.oil temperature.
iv) Over speed shut down.

Pipe Work - All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fuel oil. M.S. piping will be permitted for exhaust.

Anti Vibration Mounting- Suitable vibration mounting duly approved by Project Manager shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

Battery Charger-Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

7.6. Pump Sets Assembly

On the main fire sprinkler and hydrant headers near pump sets a 150 mm dia by-pass valve located in an accessible location shall be provided along with a rate of flow rota meter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank.

Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

17.7. Flexible Connectors

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1:5 time the operating pressure. Length of the connector shall be as per manufacturers standard.

Jockey Pump- Jockey pump shall be vertical SS type and of detail as in schedule of quantity. Contractor shall verify that the capacity of the Jockey pump shall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

G. **Operation of fire-fighting system**

k. Jockey Pump(s)

i. Jockey Pump(s) shall start when the system pressure drops by 0.5 Bars and stop when the system pressure is re-established.
ii. The operation of the Jockey Pump is controlled by Pressure Switches meant for automatic starting stopping of the Jockey Pumps of respective sprinkler and hydrant system
iii. In the event of any leakage through valve gland, there will be drop in pressure resulting the active Jockey Pump(s) of respective hydrant or sprinkler system will come in operation through Pressure Switch.
iv. In case owing to any other reasons whatsoever when the active jockey(s) pump does not come in operation, the stand-by jockey Pump(s)of respective system will come in operation automatically through pressure Switch with a timer circuit set at 30 seconds Time.
v. When the pressure reaches to a preset point, since the leakage rate is low compared to the capacity of the jockey pump, pressure would again build up within the system and the Jockey Pump of respective system will be automatically cut out through Pressure Switch.
vi. The control panel will regulate the operation of Jockey Pump and will have manual starting and stopping provision.

l. Main Hydrant and sprinkler pump(s)

i. The Fire and sprinkler Pump shall start when the system pressure drops by more than 0.98 Bars and shall continue to run till manually switched off.
ii. The system is pressurised up to the Hydrant Valves, Installation Control Valve and sprinklers through Jockey Pump.
iii. In case of any fire hazards, Hydrant valves installed around the Building or Installation Control Valve or sprinkler installed in the Building will be opened and will result to fall in pressure in the Hydrant or sprinkler header.
iv. Initially the Jockey Pump(s) will try to maintain the pressure but owing to higher demand, same would not be able to meet the water requirement and the pressure will fall further.
v. Active main fire Pump(s) meant for hydrant or sprinkler system will come in operation through pressure switch via a timer of 1 sec. which has been set for automatic starting of electric fire pump(s).
vi. In case owing to any other reasons whatsoever when the active fire pump(s)of respective system does not come in operation, the stand-by Fire Pump will come in operation automatically through pressure Switch and a timer circuit set at 60 seconds Time lag will feed the water in the system.
vii. The Main fire, sprinkler & Jockey Pumps are so interlocked that if main fire pump started operating, the Jockey Pumps will stop automatically.
viii. The control panel shall regulate the complete operation of all the pumps.
ix. The panel apart from having auto starting mode of the pumps will also have manual starting provision However, all the pumps would be stopped manually only excepting for the Jockey pumps which will start and stop automatically. The Jockey pump has also a provision for manual starting and stopping.
x. The pump control panel shall also have provision to start the diesel fire pump in case electric fire pumps are fail to start or boost the pressure within the respective hydrant or sprinkler system.
Control panel shall have provision for high and low level alarm along with system protection from dry run.

m. Electric Motors

i. Squirrel cage induction motor, TEFC type suitable for operation on 415 volts, 3 phase 50 HZ A.C supply, for the above pump with synchronous speed of 1500 RPM, conforming to IP 55/65 protection & class F insulation. Rating and design of motors and switchgears shall confirm to the relevant Indian Standard Specification. Motors shall be of continuous rating type and its rating shall be at least equivalent to the horsepower required to drive the pump at 150% of its rated discharge.
ii. Power factor of each motor shall not be less than 0.85 lagging under any conditions of load and capacitors of suitable size to raise the inherent power factor to this figure shall be included.
iii. Motors shall have EFF-2 (IE-2 as per IEC 60034-30) Efficiency ratings.

n. Pressure Gauges

i. All pressure gauges shall be of dial type with Bourdon tube element of SS 316. Gauges shall be of reputed make. Dial size shall be 100 mm dia. and scale division shall be in metric units marked clearly in black on a white dial.
ii. All pressure gauges shall be complete with isolation cock, copper tube, nipples, tail pipes etc.
iii. Dial gauges shall have adequate response for the pressures encountered within the specified(Range0-25 Kg/sq.cm or bar).
iv. Calibration certificate shall be obtained and submitted for each pressure gauge.
v. Pressure gauges shall be as per the approved manufacturer list.

o. Pressure Switches

i. Pressure switches shall be industrial type single pole double throw electric pressure switch designed for starting or stopping of equipment when the pressure in the system drops or exceeds the pre-set limits. It shall comprise of a single pole change-over switch, Bellows element assembly and differential spindle.
ii. All pressure switches shall have 6 mm B.S.P. (Table F) inlet connection & screwed cable entry for fixing cable gland.
iii. Pressure switch assemblies shall be provided for the operation of Fire pumps and other components. The assemblies shall consist of pipe work, pressure switches, pressure gauge, valves, orifice plates, and the like and such arrangement shall conform to NFPA Standards and shall be accepted by local fire authority

p. Pump Indicator

The following audible and visible indication shall be provided at the pump local control panels as applicable

i. Red "no flow" indicator with buzzer for the associated water tanks;
ii. Amber "low water level" indicator;
iii. Red "pump trip" indicator for each pump;
iv. Green "pump on" indicator for each pump;
v. "Pump electrical supply healthy" indicator for each pump;
vi. Amber "remote/local" status indicator.

q. Air Vessel

a. The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure, surges, whenever the pumping sets come into operation.
b. Air vessel shall conform to IS:3844. Air vessel plates shall conform to IS: 2002:2009.
c. It shall be normally half full of water, when the system is in normal operation.
d. Air vessel shall be fabricated with 8 mm thick M.S. plate with dished ends and suitable supporting legs.
e. It shall be provided with one 100 mm dia flanged connection from pump, one 25 mm drain with valve, one water level gauge and 25 mm sockets for pressure switches.
f. The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off

r. Automatic Level Control System (To be discussed)

i. Contractor shall provide an automatic level control system to automatically shut off pumps depending on the water level.
ii. When water reaches predetermined low level, an audio-visual alarm shall sound and the pump shall shut off automatically. The alarm shall have a manual switch, which will enable the operator to manually switch it off prior the alarm.
iii. Water pumps shall behave accordingly:

- High level alarm (over-flow)-
- Low level alarm- turn off pump
- Earthing probe.
- Alarm for no flow condition
- All status to be sent to the IBMS
-

7.2 Execution

A. Installation

a. Install control panel and alarm panel as shown on drawings.
b. Level controls shall be installed as per the manufacturers printed installation instructions. Wire level controls and pump power cords to panels.
c. Provide union, check valve and isolation valve and flexible connectors at each pump discharge line. Provide isolation valve, strainers and flexible connectors at pump suction line. Submit detailed flow verses head calculations and pump performance curves for review.
d. All installation shall be strictly as per Final approved shop drawing.

B. **Vibration Control**

Supply and install vibration isolators as required and also wherever necessary to limitvibration transmission into the building structure, supporting structure Pipe work, Pumps etc.

Ensure that any vibration transmitted from the mechanical and electrical services installations into the building structure does not exceed the 83dba at 1.5m distance.

Ensure that the maximum vibration amplitudes specified in BS 6472-1 guidelines are not exceeded.

Select vibration isolators so that they are suitable for the loading, operating and environmental conditions which will prevail. Pay special attention to vibration isolators exposed to atmospheric or adverse interior conditions and apply appropriate finishes to prevent corrosion.

The static deflection of vibration isolators shall be selected to give the necessary degree of isolation efficiency under the lowest normal operating speed of the isolated plant. Selection shall allow for asymmetric load distribution such that the minimum static deflection is achieved on all vibration isolators under normal operating conditions.

All machines and bases shall be carefully levelled. Replace any vibration isolators which are “bottomed out” or where the springs have deformed from a cylindrical shape at no extra cost to the contract.

All vibration isolators shall be colour coded or otherwise clearly marked to indicate rated load and deflection capacity to facilitate identification during installation. All external connections to vibration isolated plant shall be made using flexible connections. Particular care shall be taken to ensure that the connection of pipes etc.,to vibration isolated plant neither short circuits the plant vibration isolation, nor impedes the free movement of the vibration isolated plant.

The vibration isolation system shall be selected to support the operating weight of the plant and equipment to be isolated only. All associated pipework, valves etc., and theircontents shall be supported independently so as not to impose additional forces on the isolator system. All flexible connections shall be selected and arranged to accommodate this requirement.

All plant & pipework shall be resiliently isolated from any part of the building structure as specified, or as otherwise required, to achieve the specified noise and vibration criteria. Particular attention shall be paid to areas where low noise levels are specified. Select spring mounts with an overload capacity of 50% and with an outside diameter of at least 75% of the operating height. Mark mounts permanently with load capacity.

7.3 Testing and Commissioning

C. Testing

a. Pump shall be tested at the factory to determine the following:

i. Suction on lift or head and Discharge against the specified head when running at the rated speed under Specified.
ii. Power absorbed by the pump at the pump shaft (BP) under the above specified conditions and
iii. Efficiency of the pump under the above specified conditions.

b. Pumps shall be tested at manufacturers works and a test certificate furnished before supply and tested at site after installation as per procedure as per clause 13 of IS 5120 -1968.

D. Commissioning

a. Commissioning of the Fire Hydrant and Sprinkler Systems shall be done to the Satisfaction of Owner/ Consultant and shall commence only after:

i. All piping, accessories, pumping sets, fire alarm etc. have been completely installed and tested to the satisfaction of the Owner/Consultant.
ii. Electrical connections have been made and direction of motor rotation checked.
iii. Related work by other agencies has been completed in all respects.
iv. Water supply is available in adequate quantity in the tank.

b. On completion of all related works given above, start pumping set and develop desired pressure in the system.
c. By opening one hydrant or test valve in sprinkler system, first the jockey pump shall start automatically at desired drop in pressure and then on further fall of pressure, the main pump(s) shall start. If required, make adjustment and retest. Similarly, the stand-by pump shall also be tested for automatic starting at desired drop of pressure. While main fire pump(s) shall be suitable for manual shut-off, the jockey pump shall start and stop automatically by drop of pressure and buildup of pressure respectively.

E. Fire Protection System Testing

a. The entire works included in this Contract shall be fully tested in stages as the work proceeds and on completion of work as applicable.
b. The Contractor shall provide all necessary labour, instruments, equipment, materials, fuel, power and manufacturer's representatives to carry out such tests as may be necessary to satisfy the client / consultant that the installation meets the requirement and intent of the Specification as well as such tests required by Local Authorities.
c. All tests shall be made in the presence of the client / consultant or his representative or any inspecting authority. At least seven working days notice in writing shall be given to the inspecting parties before performing any test.
d. Three copies of all test results shall be submitted to the client on paper within two weeks after completion of the tests.
e. Tests described hereinafter and including all tests prescribed by the Authority having jurisdiction shall be carried out. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspecting parties.
f. Contractor shall submit hydraulic calculations, shop drawings along with necessary orifice plate selections for approval.
g. All piping in the system shall be tested to 1.5 times of the working pressure or 16 Bar which ever is higher hydrostatic Pressure as indicated elsewhere in this section. The pressure shall be maintained for a period of not less than 24 hours.
h. Contractor shall rectify leakages, if any, and replace all defective components and retest the system as per above requirements to the satisfaction of Project Manager / Consultant.
i. At least 5% of all the welded joints and 100% field joints shall be tested with **Dye penetrant inspection (DPI) or liquid penetrant inspection (LPI).**
j. After testing, all pipes shall be flushed with domestic water to remove foreign material.
k. Fire Protection System
l. Check all hydrant valves by opening and closing any valve found to be open shall be closed.

i. Check all the piping under hydro test.
ii. Check that all suction and delivery connections are properly made for all pump sets.
iii. Check rotation of each motor after decoupling and correct the same if required.
iv. Tests run each pump set.
v. All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).
vi. Commissioning and Testing

8. FIRE EXTINGUISHERS

8.1 General Requirements:

A. Fire extinguishers shall be worked out in such a way that the Occupants shall travel the distance recommended in IS 2190 to reach a Fire extinguisher
B. There shall be a Fire extinguisher for every 300 sq.m of floor plate / rooms / Shops of suitable type / size.
C. Extinguishers shall be provided at surface car parks, out door transformers / electrical instillations and on the landing of each staircase of all floors as indicated in the drawings.
D. Operating instruction shall be pasted on the extinguisher body.
E. Portable fire extinguishers shall be BIS approved and valid IS 15683 certificates to be furnished at the time of delivery to site.
F. Fire extinguisher shall be of stored pressure type.

8.2 Hand Fire Extinguishers

A. Hand fire extinguishers shall be enamel alloy steel cylinder, provided with a trigger or seat type valve-locking pin or a seal and discharge horn.
B. Contents of the extinguisher may be carbon dioxide, dry powder, water gas pressure, or foam, depending on fire class and storage location. Contents shall be such that no poisonous fumes or dangerous acids will be produced in any case.
C. Size and type of hand fire extinguishers shall be subject to approval by the Local Authority.
D. Fire extinguishers shall be bright red finished and provided with labels indicating dates of filling and renewal.
E. Portable fire extinguisher location shall be mentioned as below and location shall be as per drawing:
    a. Dry Chemical Powder type (IS 2171) :
    b. Water expelled CO2 Type (IS 940):
    c. CO2 type IS (2878):
    d. Mechanical Foam Type (IS 10204)

8.3 ABC Type Dry Powder Extinguisher

A. The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.
B. The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308, Part II, shall be 5 Kg +/-2% or 10 Kg +/- 3%.
C. The distribution of fire extinguishers to be as per IS 2190 – 1992.It shall be operated upright, with a squeeze grip valve to control discharge.
D. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurized with Dry Nitrogen, as expellant.
E. The Nitrogen to be charged at a pressure of 15 Kg/cm2.Body shall be of mild steel conforming to relevant IS Standards.
F. The neck ring shall be also mild steel and welded to the body. The discharge valve body shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass.
G. The nozzle shall be of brass, while the hose shall be braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it.
H. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.
I. The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm.
J. Discharge nozzles shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtr, continuously, at least for 15 seconds.
K. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for 10 Kg capacity.
L. It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside.
M. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face.

N. The extinguisher body and valve assembly shall withstand internal pressure of 30 Kg/cm2 for a minimum period of 2 minutes.
O. The pressure gauge shall be imported and suited for the purpose.

8.4 Water Type Extinguisher (Gas Pressure Type)

A. The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.
B. The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%
C. The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body.
D. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.
E. The cap shall be of leaded tin bronze, and screwed on the body up to a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring.
F. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handled fixed to it.
G. The discharge hose shall be braided nylon, of 10 mm dia. and 600 mm long, with a nozzle of brass fitted at end.
H. The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint.
I. The paint shall be stove enamelled/powder coated. The cartridge shall be as per IS, and have 60 gm net carbon dioxide gas for expelling.
J. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm2.
K. It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side.
L. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for at least 60 secs.
M. The extinguisher body shall be clearly marked with ISI stamp (IS 940).

8.5 Carbon Dioxide Extinguisher

A. The Carbon Dioxide Extinguisher shall be as per IS: 2878
B. The body shall be constructed of seamless tube conforming to IS: 7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.
C. The discharge mechanism shall be through a control valve conforming to IS:3224. The internal siphon tube shall be of copper aluminum conforming to relevant specifications.
D. Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm2 and shall be approximately 1.0 meter in length having internal dia of 10 mm.
E. The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form.
F. The handgrip of Discharge horn shall be insulated with Rubber of appropriate thickness.
G. The gas shall be conforming to IS: 307 and shall be stored at about 85 Kg/cm2. The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times, the total discharge time (effective) shall be minimum 10 secs, and maximum 25-secs.
H. The extinguisher shall fulfill the following test pressures:

    a. Cylinder: 236 Kg/cm2
    b. Control Valve: 125 Kg/cm2
    c. Burst Pressure of Hose: 140 Kg/cm2 minimum

I. It shall be an Upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking. The Extinguisher including components shall be IS mark

8.6 Mechanical Foam Extinguisher

The construction of body shall be welded and the requirement of thickness of sheet and details of the construction shall be as per IS-2825-1960 code for pressure vessels. CO2 gas cylinder used for propelling foam solution shall have necessary statutory approvals. The extinguisher shall have furnished with all accessories as needed such as filling orifice with removable s.s strainer, s.s drain plug, pressure vacuum

vent,(breather valve) pressure reducer , safety valve, level indicator etc. The charge shall be of mechanical foam compound as per IS-4989-1974 (part-11AFFF) for producing foam for fire fighting. The fire extinguisher shall be painted ' FIRE RED ' conforming to shade No 536 of IS- 5-1961.Each fire extinguisher shall be clearly marked with necessary information in English.

Technical Details

a. Tank capacity-50LTR
b. Gas (co2)- 2 kg in gas cylinder with control valve
c. Charge-AFFF (4) Foam expansion 6-8 times
d. Discharge jet length-8 to 10 mtr
e. Hose length-5 mtr
f. Tank shall be epoxy coated in side and outside the tank
g. Trolley wheel- 300mm dia solid rubber.
h. Discharge Nozzle(specially designed self aspirating branch pipe)- S.S-304.
i. Syphon tube-S.S-304.

8.7 Breathing apparatus (45 minutes duration)

Self-contained Breathing apparatus to support for 45 minutes duration conforming to IS 14170:1994 / IS : 10245 (Part IV) – 1982 and should also meet the requirement of EN 137 , Type 2 standard .Face mask to comply with EN 136 : class IIL standard

The device shall be open circuit type

The system assembly shall be complete with the following accessories

- Back plate – harness
- Full Face mask
- Demand valve
- Cylinder (CCOE tested)
- Panaramasque with silicone head straps

The back harness shall be non-metallic auto-extinguishable type and ergonomic design .The assembly shall have three carry handles and an attachment point for life line. Comfort cushions on the shoulders and belt straps. It should be compatible with full range compressed air cylinders .The cylinder collar shall be adjustable and twin cylinder version with simple addition of simple kit. It should also have a reducer with built in second user outlet.. The harness shall be with aramide fibre straps Fluorescent strips on shoulder and belt straps. Pressure gauge whistle located close to the ear. HP/MP reducer valve . By pass button on lung demand valve.

The fit of the face piece against the contours of the face shall be such that when tested in accordance with Appendix A, the inward leakage of the test contaminant between the face piece and the wearer's face shall not exceed a value of 0.05 percent of the inhaled air for any one of the ten test subjects. Face pieces are not suitable for persons with beards. Unless special fabrications are made they will also not be suitable for wearer's with spectacles having side arms. In such situations mouthpiece with nose clip should be preferred.
Face pieces shall have suitable and, preferably, replaceable eyepieces or eye shields. Eyepieces or eye shields shall be made of non-splinterable, clear and non-inflammable material.

All the test and certificates for the equipment shall meet the Appendix A,B,C,D as mentioned in IS 10245(Part(IV)-1982 (reaffirmed in 2002)

9. FIRESTOPPING AND SMOKE SEALS

Refer Annexure – 1 for technical specification of Fire Stopping and smoke Seals.

10. Hangers & Supports Summary

10.1 Material

Contractor shall allow for design , fabrication, installation and coordination with other trades for hangers, supporting system and expansion joints for the installed system.

Section Includes:

- Pipe hangers, Floor & wall supports, Vertical piping supports
- Distribution piping in shaft and chases
- Pipe anchors
- Hanger rods and accessories
- Building attachments and support insulators
- Trapeze pipe hangers.
- Metal framing systems.
- Thermal-hanger shield inserts.
- Fastener systems.
- Pipe stands.
- Pipeline Anchors & Guides.
- Equipment supports.
- Steel ropes & wires

A. General Requirements

a. Design: Design hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
b. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 or BS EN 13480.
c. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
d. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
e. The hangers and supporting system for the building shall be take care of the following effects

i. Seismic Movements(Earthquake case)
ii. Effect of Wind - Building swing (Wind case)
iii. Building settlement
iv. Expansion and contraction

f. Column shortening for any given floor(including effects of creep and shrinkage)

Important Note:

1. **The contractor shall collect the building sway movement data in wind case and earth quake case from structural engineer before proceeding for the designing / selection of hangers and supporting system.**

2. **Contractor shall also obtain seismic requirement for the project from Lodha / Architect and provide certification and mitigate for their system related to Rising Mains.**

3. **Column shortening for any given floor (including effects of creep and shrinkage) shall be as per structural consultant recommendation for the respective project**

B. Submittals

a. Contractor shall submit following calculations for hangers and supporting system for Consultant's review, Calculations shall be prepared and sealed by a qualified Structural Engineer and shall show compliance with the loading requirements. Furnish engineering calculations including, but not limited to, the following items.

i. Hanger design criteria
ii. Point loadings.
iii. Wall and column attachments.
iv. Embedment's for supporting for all horizontal and vertical piping.
v. Stresses and forces on mountings and hangers from expansion and contraction of piping.

b. Product Data: For each type of product indicated.
c. Shop Drawings: Show fabrication and installation details and for the following; include Product Data for components:

i. Trapeze pipe hangers.
ii. Metal framing systems.
iii. Pipe stands.
iv. Equipment supports.
v. Detail fabrication and assembly of trapeze hangers.
vi. Design Calculations.

d. Welding certificates.

C. Quality Assurance

a. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel." Alternatively comply with BS 2971.
b. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code. Alternatively comply with HVCA code of practice TR/5, skilled craftsmen up to class 2 standard are required.
c. Clevis or Band Hangers used for sprinkler system piping shall be UL listed and labelled. Unless otherwise stated, all steel components shall be galvanized post manufacture, according to ASTM B633 SC3.
d. Test certificate for heat aging at 1200C, as per ASTM D2240, shall be furnished for EPDM gasket used as separation between pipe and hangers.
e. Each hanger and support shall have the manufacturer's name and part number stamped on it. All hangers and supports shall be manufactured at an ISO 9001 certified facility. Manufacturer's ISO certificate, clearly stating Pipe Supports within the scope of registration, shall be furnished.

D. Pipe Hangers

a. Fire protection piping up to DN 50 (2 inch): Adjustable galvanised steel band (FM approved) hangars.
b. Multiple Hangers for Combination of services: Hot dip galvanised steel, continuous channels cast-in in concrete or suspended from ceiling. Pipe hanger / supports shall be as specified before (make appropriate selection). For piping placed above the cross member, use of U-bolts (BLine B 510 Series) shall be permitted.

E. Floor Supports

a. Ferrous piping up to DN 150 (6 inch): Adjustable pipe stanchion saddle support complete with U-bolt, stand pipe with adjuster and floor flange, use galvanised steel pipe covering shield for insulated piping.(alternatively rubber support inserts shall be installed at support points to prevent crushing of insulation).

Ref: B-Line B 3090, B 3089 and B 3151 or approved equal

b. Ferrous piping over DN 150 (6 inch): Steel pipe roll with steel base and stand. RCC / structural steel pedestals shall be provided, as appropriate, to locate the base.

Ref: B-Line B 3118 SL and B 3160 - 65 or approved equal

F. Vertical Pipe Supports

a. Ferrous piping up to DN 150 (6 inch): Galvanised steel riser clamps and / or offset pipe clamp.

b. Ferrous piping over DN 150 (6 inch): Designed and fabricated at site with the following components:

i. Gusset plates with integral bearing plates (minimum thickness equal to that of the pipe) welded to pipe.
ii. Cross channels resting on permanent construction (floor slab / block work); offset to accommodate piping insulation and attached to each other by steel flats welded at both ends
iii. `Z' cleats welded on the cross channels at the ends of the bearing plates to restrict movement
iv. Heavy duty vibration isolation pads (50 durometer) placed under bearing plates for vibration / thermal isolation
v. Vapour barrier sealed around the gusset plate with mastic sealant

G. Pipe Hangers(Anchors)

a. Shall be provided in suitable locations to control the direction and effects of movement of the pipe work systems and to resist stresses and loading on pipe work due to forces acting on the pipe work system. Use materials similar or compatible with the pipe work systems. Comply with the requirements of BS EN 13480-3.
b. Ensure structure is suitable for the transmitted stress.
c. Provide guides in accordance with the expansion joint manufacturer's requirements. Ensure that movement of pipe work is directed from anchor points towards loops and bellows and ensure thrust is along the line of the pipe work. Provide a friction reducing material between adjacent metal surfaces subject to movement.
d. The anchor and guide components shall be of suitable size and design to withstand and transfer the pipeline thrust. They shall be constructed to the general requirements of BS 13480.
e. The anchor loads, anchor and guide locations, method of fixing to the structure and design details shall be submitted and reviewed prior to commencement of the works.
f. Where bellows are used the manufacturer's recommendations shall be submitted for review and strictly adhered to.
g. Thrust blocks and suitable anchors shall be provided where pipe work internal pressures are not contained by the jointing system.
h. Install guides on each side of axial expansion joints. The first primary guide shall be located within a distance of 4 pipe diameters or 300mm, whichever is the less. The second primary guide shall be located within a distance of 14 pipe diameters from the first guide. Where axial expansion joints are positioned next to an anchor the maximum distance shall be 4 pipe diameters or 300mm, whichever is the less.

H. Anchor / Thrust block

a. Contractor shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to water hammer and high pressure
b. Thrust blocks shall be provided at all bends, tees and such other location as determined by the Employer representative.
c. Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Employer representative prior to execution of work.
d. Contractor shall submit the detailed calculation of Anchor & thrust block for Engineer's / Client's approval.

I. Hanger Rods and Accessories

a. Galvanised steel hanger rods: Galvanised mild steel rods with continuous male thread.
b. Turnbuckles: Galvanised, malleable iron castings with female threaded ends, matching with the threaded hanger rods, shall be provided where required. Back nuts shall be provided on both sides of the turnbuckle after adjustment.
c. Ball hangers: Manufacturers proprietary products shall be provided for allowing angular movement of the hanger rod, where required.
d. Threaded rod couplers: Galvanised steel unit machined from bar stock for joining two lengths of threaded hanger rods. Back nuts shall be provided on both sides of the coupler.

J. Building Attachments

a. Concrete inserts: Malleable iron or galvanised steel concrete inserts complete with adjustable insert nut, suitable for hanger rods of size 22 mm (7/8 inch) diameter and under. Galvanised steel continuous concrete insert shall be provided at the Contractor's option.
b. Self -drilling type concrete inserts: Galvanised steel self drilling expansion type concrete inserts for hanger rods up to 12 mm (½ inch) dia., shall be provided at the Contractor's option.
c. Support rails (cast-in type): Electro-galvanised steel sections with anchor lugs and filler strip complete with hammer head nut or extension pieces.
d. Support rails (surface mounted type): Electro-galvanized steel sections complete with hammerhead nut or extension pieces. The rail shall be single or double as appropriate.
e. Inserts and Expansion bolts:

i. Furnish and set inserts in concrete forms.
ii. Concrete inserts shall be as follows: Black malleable iron universal type for threaded connections with lateral adjustment for pipe sizes up to 200mm.
iii. For pipes 200 mm and over or equivalent group of pipes on trapeze, use two or more inserts to prevent exceeding maximum loading.
iv. As an alternative to the above mentioned inserts the Contractor may use expansion bolts. If the Contractor uses expansion bolts, the maximum spacing between supports may need to be reduced so as not to exceed the maximum loading and the expansion bolt locations shall be determined in coordination with the structural elements.

K. Trapeze Pipe Hangers

a. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel, G.I hanger rods, nuts, saddles, and U-bolts(Rubber lined). Alternatively comply with BS EN 13480-3 section 13

L. Metal Framing Systems

a. MFMA Manufacturer Metal Framing Systems:

i. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

ii. Please refer to manufacturers list attached with tender documents.
iii. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
iv. Standard: MFMA-4.
v. Channels: Continuous slotted steel channel with inturned lips.
vi. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
vii. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel
viii. Metallic Coating: Electroplated zinc or Hot-dipped galvanized
ix. Paint Coating: Epoxy or Polyester.
x. Plastic Coating: Polyurethane, Epoxy or Polyester

M. Fastener Systems

a. Verify suitability of fasteners in this article for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
b. Supports shall be solidly fixed to the structure using proprietary manufactured drill and plug fixing devices with removable bolt or screw. Wooden plugs, loose fill or masonry nails will not be allowed. Gun fixings will only be allowed when specifically approved.
c. At each support fixing a steel channel or angle iron section shall be secured to the structure from which pipe work, ductwork supports and brackets and equipment supports shall be attached.

d. Holes in steelwork supports and brackets shall be formed by correctly drilling, using the recommended tolerances for that which is to be inserted. Flame gun / welding torch holes burned out will not be allowed.
e. Where individual pipes up to 50mm diameter are supported on timber or lightweight walls, ceilings or partitions, brackets shall be of the screw fixing type and primary channel or angle iron brackets

shall not be used. On solid / heavy walls over 100mm thickness, individual pipe work may be supported by the use of built-in, long shank holder bats or pipe brackets.

f. Supports from the building structural steelwork shall be made using proprietary manufactured steel clamps or girder lugs. Direct drilling of the structural steelwork will not be allowed.
g. Where high level pipe work and equipment cannot be supported from the structure, a primary Galvanized steelwork supporting frame shall be provided, fixed to the floor and of suitable design to spread the load evenly, from which all pipe work and equipment shall be supported.
h. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
i. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
j. Use largest size of bolt, screw to suit diameter of hole in equipment to be fixed. Ensure that fixings are tested for tensile loading to BS 5080, this particularly applies to expanding anchors.
k. Plastic plugs of suitable size and length shall be used. Use screws to BS 1210. For fixing to concrete, brickwork or block work use sherardized steel wood screws but in damp or exposed situations use greased brass screws.
l. Obtain approval if shot fired fixings are proposed.

N. Pipe Stands

a. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
b. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
c. Low-Type, Single-Pipe Stand: One-piece GI base unit with plastic roller, for roof installation without membrane penetration.
d. High-Type, Single-Pipe Stand:
e. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
f. Base: G.I
g. Vertical Members: Two or more G.I continuous-thread rods.
h. Horizontal Member: G.I rod with plastic or stainless-steel, roller-type pipe support.
i. High-Type, Multiple-Pipe Stand:

i. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
ii. Bases: One or more; plastic.
iii. Vertical Members: Two or more protective-coated-steel channels.
iv. Horizontal Member: Protective-coated-steel channel.
v. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

j. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb & two coats of corrosion resistant red oxide epoxy paint.

O. Equipment Support

Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes & two coats of corrosion resistant red oxide epoxy paint.

10.2 Execution

A. Supports

a. Pipe work support systems shall be supported from the building structure, generally conforming with the following and where specified elsewhere:

i. BS EN 13480-3 Metallic Industrial Piping. Design and Calculation
ii. MSS SP 58, Pipes, hangers and supports- Materials Design and Manufacturer
iii. MSS SP 69, Pipes, hangers and supports- Selection and Application
iv. Manufacturer's recommendations in respect of plastic pipe.
v. EJMA Standards for expansion joints
vi. Uniform Mechanical Code
vii. Seismic Restraint Manual for Mechanical Systems.

b. Pipe work supports are to be arranged so that minimum stress is imposed upon the pipelines or ductwork. Additional supports are required on either side of equipment such as valves, strainers, and the like on pipe work. It is important to ensure that all materials used for pipe work supports are compatible with the pipeline materials.
c. The details shown elsewhere indicate brackets, and support details which may be acceptable subject to the application but the final working details, drawings or sketches shall be submitted for Review.
d. Rigid coupling may be used with IPS steel piping systems, which meet the support and hanging requirements of ASME B31.1 and ASME B31.9. An adequate number of grooved flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe and column shortening due to creepage& shrinkage.
e. Inserts

i. Inserts shall be provided to relevant Sections for placement in concrete formwork for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
ii. Hooked rod shall be provided in concrete for inserts carrying pipe over DN 150 (6 inch).
iii. Where concrete slabs form finished ceiling, inserts shall be installed flush with the slab soffit.
iv. Where inserts are omitted due to error, the slab shall be drilled through from below and through bolt with square steel plate and nut above shall be provided, recessed into and grouted flush with slab.
v. Type and quality of expansion type anchors, where used, shall be selected to suit the concrete into which it is to be installed.

f. Hanger or support assembly shall be capable of taking up the filled weight of piping for half spans on either side plus 100 kg, with minimum overall factor of safety of two.
g. Hangers shall be installed with minimum 12 mm (½ inch) space between finished covering and adjacent work.
h. Hanger shall be placed within 300 mm (12 inch) of each horizontal elbow.
i. Hangers shall have a minimum vertical adjustment of 38 mm (1½ inch).
j. Multiple or trapeze hangers shall be provided where several pipes can be installed in parallel and at same elevation.
k. Riser piping shall be supported independently of connected horizontal piping.
l. Piping shall be supported on both sides (at the system side only on connections to equipment) of flexible connections.
m. No support, hanger or anchor shall be attached to the building structural elements wherein their installation, weight or expansion stress will result in damage to the structure.
n. One coat of zinc rich primer shall be applied, after scraping and brushing the area clean, to the weld and surrounding areas, where pipe support members are welded to building structural framing.
o. Piping buried in raft slabs or trenches shall be supported as detailed on the Contract drawings. The support shall be capable of holding the pipe in position against buoyant forces exerted during pouring of concrete.
p. Pipe work supports are to be arranged so that no undue stress is imposed upon the pipes.
q. The installer will be responsible for marking out the exact positions where pipe brackets are to be built in and for checking the accuracy, levels and alignment of supports after building in by others.
r. All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets truly vertical.
s. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks.

t. Horizontal pipes running along ceiling shall be fixed on galvanized adjustable type clamps of special design as directed and as required.
u. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully reset on them.
v. Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.
w. All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred.
x. Contractor may fabricate the clamps of special nature (at the discretion of the clients representative) and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.
y. Frames shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per contractor's approved shop drawings.
z. Clamps shall be fixed in accordance to manufacturer's details/shop drawings to be submitted by the contractors.
aa. When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load.
bb. Structural clamps e.g. trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized and shall be ready made item from a reputed supplier.
cc. Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on approved shop drawings.
dd. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.
ee. All G.I Brackets should be painted with anti rust coat prior being embedded in concrete at the time of civil work itself. G.I Brackets as shown in approved shop drawings.
ff. Pipe work supports shall not exceed the maximum intervals as per manufacturer's recommendation. However the sagging of the installation will not be accepted..
gg. Additional supports shall be provided for equipment such as valves, strainers and ancillaries so that minimum stress is imposed on the pipe work and the weight is not taken by the pipe work. The support arrangement shall allow safe operation and removal of the component.
hh. All brackets and supports shall allow free movement of the pipes due to expansion and contraction with special regard to prevention of damage to any thermal insulation and vapour barrier. Fixed supports and roller/guide flexible support at appropriate locations to be provided to accommodate pipe movement due to thermal expansion/contraction and column shortening at every floor due to creep age, shrinkage and lateral displacement (wind and earth quake case and building settlement).
ii. Where multiple pipe runs of differing bores are supported from a common point, use support spacing of pipe requiring the closest spacing with adequate provision for the unequal movement due to expansion and contraction. Supports shall also be provided at bends where there is a run of pipe work 1 meter or more both sides of the bend.
jj. Cantilever type supports from walls will not be allowed except for single pipes of diameters up to 50 mm.
kk. Obtain approval for all fixings to structural concrete or structural steelwork and loads imposed on the structure. Shot fired fixings shall not be used or any reinforcement drilled through.
ll. Static point loadings transferred to the structure which cannot be accommodated by the structural fixings shall be spread over a larger area by means of additional brackets and/or additional load spreading primary steelwork.
mm. For vertical support spacing check total self-weight and pressure loading against manufacturer's recommendations when using mechanical joints or end load capable flexible couplings. Ensure adequate support when using non-end load capable flexible couplings.
nn. Direct clipping of the pipes, conduits or cables to the wall or the ceiling or any other structural members shall not be allowed.
oo. In case the supports are to be taken from the block work than the contractor shall clearly identify the locations for the solid block or lintels.
pp. In case of dry wall portions only conduits and small pipes (50mm plastic pipes) can be supported from the drywall portion frame (any extra support location shall be clearly defined) .in case of a heavy material purpose built steel frame shall be provided by the MEP trade contractor.

qq. The area which is crowded for the services installation; MEP contractor shall coordinate among themselves and design the support according to loads which will supported from the same supports.
rr. MEP Contractor is not allowed to cut any support of the drywall partition frame. This shall be coordinated on site with dry wall partition vendors before the start of the work.
ss. All the Suspended equipment and system components support shall be based on the dynamic loading of the equipment and supporting shall be designed accordingly.

B. Pipe Work Spacing

a. Provide pipe work supports such that the maximum intervals listed below are not exceeded.
b. Table 1 applies to Pressurised Pipe work listed below:

i. Steel - BS EN 10255, BS EN 10217, BS EN 10216-1
ii. Schedule 40, Schedule 30
iii. Copper - BS EN 1057
iv. Cast Iron - BS 4622
v. Ductile Iron - BS EN 545, BS EN 598 and BS EN 969

TABLE 1

Nominal PIPE BORE	MAXIMUM SUPPORT SPACING (m)					
(mm)	STEEL PIPE		COPPER PIPE		IRON PIPE	
	horizontal	vertical	horizontal	vertical	horizontal	vertical
Up to 15	1.8	2.4	1.2	1.8	-	-
20	2.4	3.0	1.4	2.1	-	-
25	2.4	3.0	1.8	2.4	-	-
32	2.7	3.0	2.4	3.0	-	-
40	3.0	3.6	2.4	3.0	-	-
50	3.0	3.6	2.7	3.0	1.8	1.8
65	3.7	4.6	3.0	3.6	-	-
80	3.7	4.6	3.0	3.6	2.7	2.7
100	3.7	4.6	3.0	3.6	2.7	2.7
125	3.7	5.4	3.0	3.6	-	-
150	4.5	5.4	3.6	4.2	3.7	3.7
200	5.0	6.0	-	-	3.7	3.7
250	5.0	6.0	-	-	4.5	5.4
300	6.1	10.0	-	-	8.0	10.0

Nominal PIPE BORE (mm)	MAXIMUM SUPPORT SPACING (m)					
	STEEL PIPE		COPPER PIPE		IRON PIPE	
	horizontal	vertical	horizontal	vertical	horizontal	vertical
350	10.0	12.0	-	-	-	-
400	10.5	12.6	-	-	-	-
450	11.0	13.2	-	-	-	-
500	12.0	14.4	-	-	-	-
600 and above	14.0	16.8	-	-	-	-

C. Adjusting

a. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
b. Support Adjustment: Piping and equipment shall be brought to the proper level by providing grout under the supports.
c. Trim excess length of continuous-thread hanger and support rods to 15 mm.

D. Cleaning and Painting

a. Touch up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.
b. Apply paint by brush or spray to provide a minimum dry film thickness of 0.05 mm.
c. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair (Zinc rich) paint to comply with ASTM A 780.

11. Noise Vibration and Seismic control

11.1 General

A. General requirements

a. This section relates to the prevention of unwanted vibration transmission from mechanical and electrical items of equipment to sensitive areas inside and outside the building.
b. Fabricate, assemble, deliver to site and install vibration control measures to meet the performance standards specified.
c. All intermediate mechanical plant room shall have necessary vibration isolation in supporting system as well as in installation.
d. In seismic control areas provide anti vibration mountings suitable for the zonal classification of the area as indicated in Section A 1.7
e. Note the requirement to reselect vibration control equipment to suit the final actual operating weights and speed of operation of plant.
f. The Contractor shall be responsible for ensuring that the acoustic performance of the equipments meets the design criterion described in the relevant sections of the project specification at the date of equipment procurement.
g. The Contractor shall furnish the complete acoustic report of the equipment prior to start of the procurement procedure.

11.2 Quality Assurance

A. Ensure that the design, construction, materials and finishes of all equipment are suitable for the location, climatic and operating conditions to which the installation will be exposed.
B. Ensure that the whole installation complies with the relevant standards, including the following:

- BS 4800 - Schedule of paint colours for building purposes
- BS 6472-1 - Guide to evaluation of human exposure to vibration in buildings Vibration sources other than blasting
- BS EN ISO 9001- Quality management system requirements.
- IS 1893 -Criteria for Earthquake resistant design of structures.
- ISO-7235- Guide to evaluation of human exposure to vibration in buildings, vibration sources other than blasting
- NEBB- National Environmental Balancing bureau.

11.3 Submittals

A. Provide a fully documented set of the calculations upon which the vibration equipment has been selected.
B. Contractor shall submit the typical details of equipments with the vibration isolations details as per acoustic consultant's requirement.

11.4 Vibration Control

A. Vibration Isolators – General

a. Supply and install vibration isolators as indicated on the vibration isolation schedules and also wherever necessary to limit vibration transmission into the building structure, supporting structure Pipe work, Pumps etc.
b. Ensure that any vibration transmitted from the mechanical and electrical services installations into the building structure does not exceed the 83dba at 1.5m distance.
c. Ensure that the maximum vibration amplitudes specified in BS 6472-1 guidelines are not exceeded.
d. Select vibration isolators so that they are suitable for the loading, operating and environmental conditions which will prevail. Pay special attention to vibration isolators exposed to atmospheric or adverse interior conditions and apply appropriate finishes to prevent corrosion.

e. The static deflection of vibration isolators shall be selected to give the necessary degree of isolation efficiency under the lowest normal operating speed of the isolated plant. Selection shall allow for asymmetric load distribution such that the minimum static deflection is achieved on all vibration isolators under normal operating conditions. All machines and bases shall be carefully levelled.

f. Replace any vibration isolators which are "bottomed out" or where the springs have deformed from a cylindrical shape at no extra cost to the contract.

g.

h. All vibration isolators shall be colour coded or otherwise clearly marked to indicate rated load and deflection capacity to facilitate identification during installation.

i. All external connections to vibration isolated plant shall be made using flexible connections. Particular care shall be taken to ensure that the connection of pipes etc., to vibration isolated plant neither short circuits the plant vibration isolation, nor impedes the free movement of the vibration isolated plant.

j. The vibration isolation system shall be selected to support the operating weight of the plant and equipment to be isolated only. All associated pipe work, valves etc., and their contents shall be supported independently so as not to impose additional forces on the isolator system. All flexible connections shall be selected and arranged to accommodate this requirement.

k. All plant & pipe work shall be resiliently isolated from any part of the building structure as specified, or as otherwise required, to achieve the specified noise and vibration criteria. Particular attention shall be paid to areas where low noise levels are specified.

l. Select spring mounts with an overload capacity of 50% and with an outside diameter of at least 75% of the operating height. Mark mounts permanently with load capacity.

B. Vibration Isolation Plant and Equipment

a. Unless otherwise stated, plant and equipment isolators shall be provided as indicated on the following schedules. For specification of isolator types refer to the following clauses. Isolators must be selected for the operating weight of equipment and shall be positioned for equal deflection.

b. Un housed Spring Mounts (Type S)
Provide where indicated on the vibration isolation schedule unhoused spring mounts. The mountings shall comprise of free standing, unhoused, laterally stable steel spring with a top and bottom load plate and levelling bolt.

c. Vertically Restrained Spring Mounts (Type L)
Provide where indicated on the vibration isolation schedule vertically restrained spring mounts. The mountings shall comprise high strength; low stress helical steel and springs capped with steel pressure plate on neoprene base pad. Supply base plate pre-frilled for bolting down and painted for protection. Supply unit complete with lockable levelling device to limit the vertical movement.

d. Pre-Compressed Moulded Glass Fibre Mounts (Type F)
Provide where indicated on the vibration isolation schedule pre-compressed moulded glass fibre mounts. The mountings shall be composed of inert inorganic material covered with an elastomeric coating to increase damping and protect the glass fibres. The isolation pad shall be bonded to a steel load transfer washer and formed steel bolt down bracket and shall include a steel bolt with a neoprene grommet.

e. Spring Compression Hangers (Type H)
Provide where indicated on the vibration isolation schedule spring hanger mountings. In addition spring hangers shall be used to support all pipe work and ductwork connected to rotating and reciprocating machinery within plant room areas or within 15 m of the plant which ever is the lesser. When used for supporting pipe work and ductwork the springs shall have a minimum deflection of 25mm unless otherwise stated. The hangers shall comprise of a steel spring or glass fibre pad or a combination of both retained in a welded steel bracket. The steel spring shall be free standing, unhoused and laterally stable having horizontal spring stiffness equal to or greater than 1.3 times the vertical stiffness. The hanger bracket shall be designed to carry five times overload without failure and shall allow up to 15mm dia rod misalignment without metal to metal contact.
Neoprene Mounts (Type N)
Provide where indicated on the vibration isolation schedule Kinetic neoprene isolators. The moulded neoprene isolators shall be complete with a cast in tapped steel load plate to permit bolting to supported equipment and a cast in steel anchor base plate pre-drilled for holding down bolts. The neoprene shall be oil and corrosion resistant.

f. Inertia Bases (Type S-I) Provide where indicated on the vibration isolation schedule inertia bases manufactured from welded steel channels designed to receive concrete poured into the steel

frame. The steel frame shall incorporate pre-located equipment anchor bolts and free-standing laterally stable spring mounts generally as described under type S mounts.

g. Inertia Bases (Type L-I)
Provide where indicated on the vibration isolation schedule inertia bases generally as type S-I except that the springs shall be type L vertically restrained.

h. Inertia Bases (Type F-I)
Provide where indicated on the vibration isolation schedule inertia bases generally to type S-I except that the isolators shall be moulded glass fiber isolators as described under type F mounts.

i. Steel Base Frames (Type S-B)
Provide where indicated on the vibration isolation schedule steel frame bases manufactured from structural steel members incorporating isolator mounting brackets and supported by free standing spring isolators as described under type S mounts.

j. Steel Base Frames (Type L-B)
Provide where indicated on the vibration isolation schedule steel beam bases manufactured from structural steel members incorporating isolator mounting brackets and supported by vertically restrained spring isolators as described under type L mounts.

C. Flexible connections general

a. Flexible connections shall be fitted to all Pump Suction and Discharge connections, centrifugal reciprocating or vibrating equipment where it is marked on the drawing, and where anti-vibration mounts, inertia bases are fitted.

b. Flexible Connections must have been tested for Noise and Vibration reduction capabilities, with due Certification being submitted to the Engineer for approval prior to the order being placed.

c. Flexible Connections are to be fitted as close to the source of vibration as practicable. The pipe at the other end of the Flexible Connection is to be a fixed point. This is necessary to reduce the noise, vibration and resonances from the distribution pipe work to the building fabric, and prevent any stresses in the pipe work from being transmitted upon the pump or vibrating equipment. To ensure correct alignment, a spool piece is to be employed during installation.

d. Rubber Flexible Connections shall be single convolution of hand laid multi ply reinforced EPDM rubber with wire reinforced cuffs. Flanges shall be removable and suitably profiled to control the convolution shape; plate flanges must not be used.

e. To avoid over tightening and damaging the sealing face of the rubber bellows the flanges shall be designed to make metal to metal contact with its mating flange when fully tightened.

f. Threaded and adjustable tie bars with rubber top hat washers shall be used where the working pressure exceeds 1.5 bar g. When untied Flexibles are used, the manufacturer's recommendations for anchors and guides shall be followed to prevent forces being exerted on to the pump casing and AV mounts.

g. All flexible connections shall be compliant with the PED (Pressure Equipment Directive) and be stamped with the CE mark

D. Stainless flexible connections for temperature above 100°C

For temperatures above 100°C Flexible Connection must not be manufactured from Rubber, but shall be of stainless steel thick wall spirally wound multi-ply construction to provide the required noise and vibration reduction. The flexible shall be 130mm long and provided with Van Stone ends and swivel flanges. This type of Flexible Connection being for installations where the pump is on "solid" AV mounts

E. Flexible for use with equipment on spring type supports.

For installations where the pump and/or pipe work is on spring type supports, the flexible shall be as indicated above (rubber of stainless steel), but shall be a lateral type unit with a double membrane to give greater flexibility for this type of installation.

F. Flexible hoses

a. Provide where indicated on the drawings or as required. Rubber type has limited life and temperature. Rubber type not suitable for potable water services. Stainless steel type not suitable for elevated chlorine levels in excess of 200ppm.

b. Rubber type: Comprise unreinforced 3mm thick EPDM rubber liner with a stainless steel braid. Fittings are swaged using AISI 304 stainless steel ferrules suitable for design temperatures -10°C to 100°C.

c. Vibration Isolation Schedule

Equipment type	Equipment location									
	Basement		Ground or up to 6m floor span		9m floor span		12m floor span		15m floor span	
	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)
Fire Pumps										
Close coupled up to 7.5 kW	N *	9	N	9	S-B	25	S-B	25	S-B	25
Close coupled over 7.5 kW	S-I *	19	S-I	25	S-I	38	S-I	62	S-I	62
Base mounted and belt driven up to 7.5 kW	F-I *	9	F-I	9	S-I	38	S-I	44	S-I	62
Base mounted and belt driven over 7.5 kW	S-I *	25	S-I	25	S-I	44	S-I	62	S-I	88

*** NOTE: For Fire Protection Pumps, there will no Inertia bases and pumps will be mounted on PCC blocks with anti vibration rubber mounts.**

11.5 Installation and Testing

a. Carry out commissioning tests in accordance with this specification.
b. Demonstrate at commissioning stage, to the satisfaction of the Clients representative, that all specified vibration levels have been achieved.
c. When installing anti-vibration mountings comply with manufacturer's instructions.
d. Level equipment to ensure loads are evenly distributed.
e. Protect all equipment from damage by ingress of water or dirt.

11.6 INERTIA BASE

A. REFERENCE CODES & STANDARDS / GOOD ENGINEERING PRACTICE AND ASSURANCE

Codes and Standards: The following will/shall apply and conform to good engineering practices unless otherwise directed by the Federal, State or Local authorities having jurisdiction. (Reference Code By Jurisdiction – listed below):

a. American Society of Civil Engineers 7-05.
b. SMACNA (Sheet Metal and Air-conditioning Contractors' National Association's).
c. ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers).
d. VISCMA (The Vibration Isolation and Seismic Control Manufacturers Association) has developed Testing and Rating Standards for Vibration Components that comply with Code and ASHRAE based requirements.

B. SUBMITTALS

a. Product Data: Include Vibration Rating Data for each vibration rated isolator or restraint component.
b. Samples: The contractor shall submit samples of specified vibration isolators / snubber devices upon request of the engineer for approval.
c. Submit shop drawings for all devices specified herein and as indicated and scheduled on the drawings. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, attachments and anchorage requirements. Shop Drawings shall include the following:

i. Vibration Isolation Bases: Dimensional drawings including anchorage and attachments to structure and to supported equipment, if needed or required. Include auxiliary motor slides and rails, base weights, equipment static loads.
ii. Vibration Restraint Details: Detailed submittal drawings of vibration restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Include ratings for loads.
iii. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. COORDINATION

a. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration isolated equipment. Concrete shall have a minimum compressive strength of 3,000 psi or as specified by the project engineer. {Also see requirements in the seismic / wind portion of this spec}.
b. Coordinate with vibration isolation restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration isolated restrained equipment (e.g. roof curbs, cooling towers, chillers and other similar equipment).
c. The materials and systems specified in this section shall be purchased by the mechanical contractor from a single vibration isolation / snubber restraint materials manufacturer to assure sole source responsibility for the performance of the vibration support system used.
d. The materials and systems specified in this section can, at the contractor's option, be installed by the subcontractor who installs the mechanical equipment, piping, or ductwork.

D. PRODUCTS

VIBRATION ISOLATION: Materials and systems specified herein and detailed or scheduled on the drawings are based upon materials manufactured. Materials and systems provided by other manufacturers are acceptable pending engineering written approval, provided that they meet all requirements as listed in this specification.

a. Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have kx/ky ratios of at least 0.9. All springs shall be fully colour-coded to indicate capacity – colour striping is not considered adequate.
b. Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.
c. Steel Equipment Base: Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.

i. Vibration bases for fans shall have adjustable motor slide rails as indicated on their Schedule, and shall accommodate motor overhang.
ii. Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.
i. Minimum clearance under steel equipment bases shall be 25mm (1").

d. Concrete Inertia Base: Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate reinforcing bars, spaced 300 mm (12") maximum on centers each way.

ii. Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections (if this information has been provided for configuration.
iii. Inertia bases for fans shall include motor slide rails as indicated on their Schedule.
iv. The weight of each inertia base shall be at least (1.5 times(x)) to the weight of the equipment mounted thereon or sufficient to lower the center of gravity to or below the isolator support plane.
v. Inertia bases shall be a minimum of 150 mm (6") thick. (See ASHRAE Standards).

e. Isolators:

i. Free Spring Floor Mounted Isolators: Type FDS – Vibration isolators shall be free standing, un-housed, laterally stable springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Springs shall be selected to provide operating static deflections as required. Springs shall be color coded or otherwise identified to indicate load capacity. In capacities up to 5,000 lbs., springs shall be replaceable. In capacities over 5,000 lbs., springs shall be welded to the top and bottom load plate assemblies. Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel levelling bolt lock nut and washer for attachment to the supported equipment. The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
ii. Restrained Spring Floor Mounted Isolators: Type FLS – Vibration isolators for equipment which is subject to load variations and large external or torquing forces shall consist of large diameter laterally stable steel springs assembled into formed or welded steel housing assemblies designed to limit vertical movement of the supported equipment. Springs shall be supported either with a neoprene cup of a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Housing assembly shall be formed or fabricated steel members and shall consist of a top-load plate complete with adjusting and levelling bolts, vertical restraints, isolation washers and a bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure. Housing shall be hot dipped galvanized. Spring elements shall meet all the specified characteristics described in Section 2.1/E.1 paragraph.
iii. Vibration Modular Restrained Spring Isolator: Type FMS (A, B, C, D, E, F) – Spring isolators shall be comprised of two interfacing but independent elements; a coil spring element and a seismically rated housing. The spring coil element shall be comprised of one or more coil assemblies having all of the characteristics of freestanding coil spring isolators as specified in the vibration isolation portion of the specification. The seismically rated housing shall be sized to meet or exceed the force requirements applicable to the project and have the capability of accepting coils of various sizes, capacities, and deflections as required to meet the desired isolation criteria. All spring forces will be contained within the coil/housing assembly and under no seismic load condition shall the restraint anchoring hardware be exposed to spring - generated forces. The restraint element shall incorporate a steel housing with elastomeric elements at all dynamic contact points. The restraint will allow a maximum of 1/4 in. (25 mm) motion in any direction from the neutral position. All elastomeric elements shall be replaceable. To ensure the optimum anchorage capacity, the restraint will have an overturning factor (the ratio of the effective lateral snubber height to the short axis anchor spacing) of 0.33 or less. The levelling nut or screw shall be accessible for adjustment with the use of a pneumatic or electric impact wrench. The spring element shall be replaceable without having to lift or otherwise remove the supported equipment. Spring elements shall meet all the specified characteristics described in Section 2.1/E.1 paragraph.

iv. Rubber-in-Shear / Fiber glass Floor Mounts:

- Vibration isolators shall be pre-compressed molded fibreglass pads individually coated with a flexible, moisture impervious elastomeric membrane. Vibration isolation pads shall be molded from glass fibers with all strands oriented horizontally. Natural frequency of fibreglass vibration isolators shall be essentially constant for the operating load range of the supported equipment. Vibration isolators shall be color coded or otherwise identified to indicate the load capacity. Vibration isolators shall be selected by the manufacturer for each specific

application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.

- b. Vibration isolators shall be as described as in Section 2.1/E.1 paragraph bonded to a steel load transfer plate and a formed steel bolt-down bracket, and shall also include an equipment-mounting bolt with an anti-short circuit neoprene grommet. Anchored vibration isolators shall be as per manufacturer standards
- Vibration isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capabilities.
- All Direction Neoprene Isolator: Vibration Isolators shall be neoprene, molded from oil resistant compounds, designed to operate within the strain limits of the isolator so to provide the maximum isolation and longest life expectancy possible using neoprene compounds. Isolators shall include encapsulated cast-in-place top steel load transfer plate for bolting to equipment and a steel base plate with anchor holes for bolting to the supporting structure. Ductile iron or cast aluminum components are not acceptable alternatives and shall not be used due to brittleness when subjected to shock loading. Isolator shall be capable of withstanding the design seismic loads in all directions with no metal-to-metal contact. Isolator shall have minimum operating static deflections as shown on the project Vibration Isolation Schedule or as otherwise indicated in the project documents and shall not exceed published load capacities.
- Neoprene Isolator: Neoprene isolator with a 3-axis restraint capability. It would be usable for floor, wall, and ceiling applications. The deflection of the isolators in the, confined mode, will be between 0.25” and 0.33” depending on the rated load. The natural frequency if loaded to the rated value would be between 6.25 Hz and 5.45 Hz.

v. Spring Hangers:

Vibration isolator hanger supports with steel springs and welded steel housings. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit. Hangers serving lightweight loads 0.90 kN (200 lbs) and less may be exempt from this requirement. {*When used in a seismic application(s), a vertical limit stop washer sized to fit the hanger rod is to be provided by others*}.

- Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding .4", shall be hangers consisting of a free-standing, laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. The spring element shall meet all the specified characteristics described in Section 2.1/E.1 paragraph. The stamped or welded hanger bracket shall meet all the specified characteristics described in Section 2.1/E.7 paragraph. Shall also be fitted with a self-centering load cap for the hanger rod.
- Vibration isolators for suspended equipment with minimum static deflection requirement exceeding .4", and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable steel spring in series with a molded oil-resistant neoprene insert, complete with load transfer plates and assembled in stamped or welded steel bracket. The spring element shall meet all the specified characteristics described in Section 2.1/E.1 paragraph. The stamped or welded hanger bracket shall meet all the specified characteristics described in Section 2.1/E.7 paragraph.
- Vibration isolators for suspended equipment with minimum static deflection requirement exceeding .4", and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable steel spring in series with a pre-compressed molded fibreglass insert, complete with load transfer plates and assembled in a stamped or welded steel bracket. The fibreglass insert element shall meet all the specified characteristics described in Section 2.1/6.a paragraph. The spring element shall meet all the specified characteristics described in Section 2.1/E.1 paragraph. The stamped welded hanger bracket shall meet all the specified characteristics described in Section 2.1/E.7 paragraph.

vi. Neoprene Hangers:
Type RH – Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding .40" shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit.

vii. Vibration Isolation Pads:

- Isolation pads shall be neoprene elastomer in-shear pads, used in conjunction with steel shims where required, having static deflections as tabulated. Kinetics RSP neoprene pads are produced from a high quality neoprene elastomer. Pads are 50 durometer and are designed for a maximum of 60 psi (4.2 kg. / sq. cm) loading. Pads are designed for a maximum deflection of approximately 20% of its unloaded thickness, 0.15" (0.38 cm). Several layers of RSP pads can be stacked for additional deflection when steel separation shim stock is used. The elastomer is oil and water resistant, offers a long life expectancy consistent with neoprene compounds, and has been designed to operate within the safe stress limits of the material. RSP pads are available up to 18" x 18" x 3/4" (457 mm x 457 mm x 19 mm) thick sheets and are pre-scored into 2" x 2" (51 mm x 51 mm) squares and can be easily cut-to-fit as needed. All pads shall be elastomer in-shear and shall be molded using 2500 psi minimum tensile strength, oil resistant neoprene compounds with no color additives. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule, or as indicated on the project documents, but not exceeding published load capabilities.
- Isolation pads shall be single ribbed or crossed, double ribbed elastomer-in-shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All pads shall be true elastomer-in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 PSI (176 kg/cm2) tensile strength, oil resistant compounds with no color additives. Pads shall be 45 to 65 durometer and designed to permit 60 or 120 PSI (4.2 or 8.4 kg/cm2) loading at maximum rated deflections. When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate. Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule or as indicated on the project bid documents, not exceeding published load capabilities
- Fiberglass continuous support material shall be high-density matrix of compressed molded fibreglass; individually coated with a flexible, moisture-impervious elastomeric membrane, designed to allow controlled air movement in the fiber media. It shall be manufactured in such a way that the pumping action of air between fibers provides viscous damping, reducing motion caused by transient shock and vibration. The material is to be non-corrosive, non-combustible, non-absorbent, and resists rust, ozone, mildew and fungus, vermin proof and it will not shrink, swell, or decompose. Isolation characteristics of the media are to be constant over a temperature range of -40℉ to 250℉ (40℃ to 121℃).

viii. Curb-Mounted Spring Rail:

Type KSR – Full-perimeter rail type isolator, spring components shall be (1"/25 mm), (2"/51 mm) deflection, free-standing, un-housed, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed for 50% overload to solid. The spring element shall meet all the specified characteristics described in Section 2.01/E.1 paragraph. Springs shall be color coded to indicate load capacity. Rails shall provide continuous support for the rooftop equipment and shall be designed to provide isolation against casing-radiated vibration in the rooftop equipment housing and structure-borne vibration from rotating and mechanical equipment in the rooftop package. Rail assembly shall consist of extruded aluminum top and bottom members connected by spring isolators and a continuous air- and water-tight seal. The seal shall be a beaded elastomeric material retained in a keyway along the top extrusion. The weather strip shall be sealed along the bottom with an aluminum fascia strip. Rail assemblies shall incorporate means for attachment to the building and the supported equipment and shall incorporate additional stiffening members if necessary to assure stability. Rails shall be fitted with wind restraint devices suitable for prevailing wind conditions that will not impose loads on the curb walls at 90 degrees to their long axis. Vibration isolators shall be selected by the

manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.

ix. Vibration Restrained Curb-mounted Spring Rail:

Type KSCR – All rooftop air-handling units shall be supported by vibration isolation curbs as manufactured by Kinetics Noise Control. The vibration isolation curbs shall be complete assemblies designed to resiliently support the equipment at the specified elevation and shall constitute a fully enclosed air- and weather-tight system. The isolation curb shall consist of an upper support rail with supply and return flexible connector supports on which the equipment and duct openings rest and a lower support curb which is attached to the roof structure, separated by freestanding, un-housed, laterally stable steel springs and lateral seismic and/or wind load restraints. The upper support rail shall provide continuous structural support for the rooftop equipment and shall be designed to provide isolation against casing-radiated vibration in the rooftop equipment housing and structure-borne vibration from rotating and mechanical equipment in the rooftop package. The upper support rail shall consist of an extruded aluminum structural shape with a minimum height of 4.75" (121 mm) above the spring to preclude interference with the rooftop equipment. The upper support rail extrusion shall include a continuous keyway to accommodate the beaded elastomeric weather seal and a channel to maintain proper spring alignment. The lower support curb shall be a formed channel fabricated of heavy gauge galvanized steel with a continuous 1-1/2" x 1-1/2" (38 mm x 38 mm) nominal wood nailer. The base plate of the curb shall be 1" (25 mm) wide and shall be welded, bolted or screwed to the building support steel. The lower support curb shall have a minimum elevation of 14" (356 mm). Spring components shall be 1" (25 mm) 2" (51 mm) deflection, freestanding, un-housed, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed for a typical 50% overload to solid. All springs shall have an polyester powder coated finish and be color coded to indicate load capacity. Springs shall rest on a neoprene noise pad. The spring and noise pad shall be captured in a retainer cap secured to the lower support curb. The lateral stabilizers (pat. pending) shall be stainless steel spring assemblies factory located and installed to provide seismic and/or wind load restraint. Standard units are designed to withstand a 43 psf. horizontal and 25 psf. vertical wind load. Resistance to higher loads or for ratings on extended height curbs or units attached to wood or concrete will require analysis by KNC, but can in most cases be met with only minor modification. The weather seal shall run continuously around the perimeter of the curb and be joined in the field with one seam using a double-faced elastomeric adhesive. The weather seal shall be fastened to the wood nailer of the lower support curb using screws and an aluminum fascia strip. Supply and return flexible connector support hardware shall be supplied for installation by the contractor in the field. The supports will be clearly marked and dimensioned on the submittal and installation drawings. The support hardware shall be cut-to-length galvanized steel channels supported and connected with stamped and punched galvanized steel duct support hangers. The support hangers shall allow the duct support elevation to be equal to or lower than the equipment rail elevation. Supply and return air duct shall be flexibly attached by the contractor to prevent transmission of vibration to the building structure. The isolation curb assembly shall include a troubleshooting kit to permit the contractor to level or adjust the loading of the isolation system immediately after placement of the rooftop equipment should the actual weight and/or distribution differ from design values. Vibration isolators shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents. Roof Curb Rails with an Integral Curb.

x. Spring Isolation Roof Curb: Type ESR – Curb type isolator with integral spring isolators, designed to provide a complete roof curb installation. All rooftop air-handling units shall be supported by vibration isolation curbs as manufactured by Kinetics Noise Control. The vibration isolation curbs shall be complete assemblies designed to resiliently support equipment at the specified elevation and shall constitute a fully enclosed air- and weather-tight system. The isolation curb shall consist of an upper support rail with supply and return duct supports on which the equipment and duct openings rest and a lower support curb which is attached to the roof structure, separated by free-standing, un-housed, laterally stable steel springs. The upper support rail shall provide continuous structural support for the rooftop equipment and shall be designed to provide isolation against casing radiated vibration in the rooftop equipment housing and structure borne vibration from rotating and mechanical equipment in the rooftop package. The upper support rail shall consist of a structural channel with sufficient elevation above the spring to preclude interference with the rooftop equipment and permit access to inspect the isolation system after placement of the rooftop

equipment. Attachment to of the RTU by weather seal attachment bolt heads is not permitted. The lower support curb shall be a formed channel fabricated of heavy gauge galvanized steel with a continuous 1-1/2 inch x 1-1/2 inch (38 mm x 38 mm) nominal wood nailer attached to the isolation support pedestals. The isolation support pedestal, which includes the seismic and wind load restraints, shall be bolted or welded to the building support steel to suitably transfer seismic and wind load forces to the building structure. The lower support curb shall have a minimum elevation of 14 inches (356 mm) from the top of the wood nailer to the base of the curb. Spring components shall be (1 inch/25 mm) (2 inch/51 mm) (4 inch/102 mm) deflection, free-standing, un-housed, laterally stable steel springs. Springs shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed for a typical 50% overload to solid. All springs shall have a polyester powder coated finish and be color coded to indicate load capacity. Spring coils shall rest on minimum 0.25 inch (6 mm) neoprene noise pads. The isolation curb system shall be complete with cross-bracing as required as a part of the upper and lower assemblies. Supply air and return duct shall be flexibly attached by the contractor to prevent transmission of vibration to the building structure. Airborne noise control packages, if required, shall be supported by the roof structure within the curb and shall have no rigid contact with the isolation curb. Vibration isolators shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.

E. Execution

a. Vibration installation

i. Installation of all vibration isolation materials and supplemental equipment bases specified in this section shall be accomplished as per the manufacturer's written instructions and adjust mountings to level equipment.
ii. On completion of installation of all isolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.
iii. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system herein specified. Electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment.
iv. Ensure pipe, duct and electrical connections to isolated equipment do not reduce system flexibility. Ensure that pipe, conduit and duct passing through walls and floors do not transmit vibrations.
v. Unless indicated otherwise, piping connected to isolated equipment shall be isolated as follows:

- Up to (NPS) 4" Diameter: first 3 points of support. (NPS) 5" Diameter to (NPS) 8" Diameter: first 4 points of support. (NPS) 10" Diameter and Over: first 6 points of support.
- First point of support shall have a static deflection equal to the deflection of isolated equipment; with a maximum of 2" (50 mm). Subsequent support points shall have a static deflection no less than 1" (25mm).
- Deflection shall be not less than that for the equipment to which the piping is connected.
- Block and shim level bases so that the ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

F. VIBRATION ISOLATION INSPECTION

a. The contractor shall notify the local representative of the vibration isolation materials manufacturer prior to installing any vibration isolation devices. The contractor shall seek the representative's guidance in any installation procedures with which he is unfamiliar.
b. The local representative of the vibration isolation materials manufacturer shall conduct periodic inspections of the installation of materials herein specified, and shall report in writing to the contractor any deviations from good installation practice observed.
c. On completion of installation of all noise and vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall (only upon request as required) inspect the completed system and report in writing any installation errors, improperly selected isolation devices, or other fault in the system that could affect the performance of the system

12. Expansion Fittings and Loops

12.1 General

Section Includes:

A. Expansion Loops.
B. Mechanical Expansion Joints
C. Unrestrained Expansion Joints.
D. Restrained Expansion Joints.
E. Alignment guides and anchors.
F. Flexible Connections

12.2 Performance Requirements

A. Responsibility of Contractor:

a. Determine required system expansion, compensation, and location of all guides anchors and expansion devices using finalized contractor's installation drawings.
b. Design and provide expansion compensation devices, equipment and anchors.
c. Provide calculations by a licensed professional engineer substantiating that expansion compensation is designed to meet all system expansion requirements and safely accept generated forces without failure.
d. Coordinate expansion requirements with the work of other trades.
e. Provide structural engineer with required loads and forces required to support and restrain piping. Approval of these loads is required prior to pipe work installation commencing.

B. Provide sufficient supports, fixing and pipe work components in such a manner that expansion and contraction of the pipe work is fully accommodated.
C. Generally movement shall be accommodated at all changes in direction and/or at terminations of pipe work.
D. Branch connections or pipe junctions to main pipe work shall be made with 2 Nr 90° changes in direction to form an offset of suitable length to facilitate the expansion/contraction and prevent excess strains on the pipe work joints at the junctions.
E. Where expansion or contraction of pipe work cannot be accommodated as described above expansion loops or mechanical expansion joints shall be provided.
F. The application, location and type of joints shall be in accordance with BS 6129-1.
G. Where expansion devices are installed the correct amount of "cold draw" must be applied and adequate provision shall be made for temporary clamps or spacer pieces during the testing operations defined elsewhere.
H. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures. Mechanical expansion devices and flexible connections used on water services piping shall be WRAS approved, or similarly approved for potable water systems by the local municipality.
I. Capability: Products to absorb 200 percent of maximum axial movement between anchors.
J. Provide & Comply to lateral displacement (wind case &earthquake case) building settlement and column shortening (due to creepage and shrinkage) requirements specified in section B.1-clause E& F.

12.3 Submittals

A. Product Data: For each type of product indicated.
B. Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

a. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
b. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
c. Alignment Guide Details: Detail field assembly and attachment to building structure.
d. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.
D. Product Certificates: For each type of expansion joint, from manufacturer.
E. Maintenance Data: for expansion joints to include in maintenance manuals.
F. Expansion joints calculation for vertical risers: Furnish movement calculation based on the following criteria:
   a. Minimum creepage and shrinkage factor of 3mm per floor.
   b. Thermal expansion and contraction
   c. Lateral displacement(wind & earthquake case) & building settlement as specified in section B.1-clasue E & F

12.4 Quality Assurance

A. Comply with the following:
   a. BS 13480-3- Metallic industrial piping. Design and calculation
   b. BS 6129-1 - Code of practice for the selection and application of bellows expansion joints for use in pressure systems. Metallic bellows expansion joints
   c. EJMA "Standards of the Expansion Joint Manufacturers Association"

12.5 Products

A. Expansion Systems

   a. Where possible provision for movement due to thermal expansion and contraction shall be made by natural changes in the direction of pipe work. Provide expansion loops or mechanical joints if necessary.
   b. Anchors and guides shall be positioned to contain all movement and resist the maximum loads imposed.
   c. Anchors and guides are to be located at points which prevent excess stresses on pipe work, joints and equipment connections.
   d. Similar provisions shall be made for building movement or building settlement.

B. Expansion Loops General

   a. Prefabricated expansion loops shall be constructed in the same pipe work class and finish as the pipe work system.
   b. Where access is limited prefabricated expansion loops shall be used and only on pipe work up to 65 mm.

C. Expansion Loops – Steel (As Applicable)

   a. Provide expansion loop in the material and finish of the associated pipeline. The loop shall be sized to limit the total stress set up in the material of the pipe wall to less than 69 MPa. The Contractor shall supply calculations for approval by the engineer.
   b. Bends shall be from a single length of pipe or by welding fittings if expansion loops are too large to manufacturer in the piece.
   c. Drawings indicating the method of anchoring and guides shall be supplied to the engineer for approval.
   d. The spacing of the supports shall not exceed the centers given in the pipe work section. Where there are two or more pipes the spacings shall be based in the centers required by the smallest bore pipe work.
   e. Vertical rising pipe work shall be supported at the base or, as required to withstand the total weight of the riser and thrust.

D. Mechanical Expansion Joints

   a. Where natural flexing of the pipe work is not practical thermal expansion and building movement shall be accommodated by the use of expansion joints.
   b. Expansion joints may be of the restrained or unrestrained type and shall be provided with welded, screwed or flanged ends as appropriate.
   c. Expansion joint convolutions shall be of a thick wall spirally wound, multi-ply construction with a corrosion resistant inner ply in AISI 316L stainless steel. Units should be fitted with stainless steel inner sleeves, in compliance with EMJA.

d. Expansion joints shall be capable of not less than 5000 complete reversals of movement at the given working conditions and the manufacturer shall be able to produce calculations to that effect, in full compliance with EJMA (Expansion Joint Manufacturers Association).
e. Expansion joints shall be capable of withstanding a test pressure 1.5 times the design working pressure without deformation.
f. Expansion joints and their corresponding anchors and guides shall be indicated on the shop drawings and shall be installed strictly in accordance with the manufacturer's instructions and guidelines.
g. All mechanical expansion joints shall be in accordance with BS 6129-1 or EJMA Standards by the expansion joints. They shall be provided with flanged or screwed ends to BS EN 1092-1 and BS EN 10226-1 or ANSI B16.3 and ANSI B16.1, respectively, as appropriate. They shall be manufactured from stainless steel appropriate to the working pressures of the various systems. They shall be supplied with external protective sleeves.
h. Grooved flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe and column shortening due to creepage& shrinkage.
i. The manufacturer's requirements shall be complied with and anchor loads shall be calculated and their proposed locations approved prior to commencement of the works. Where axial bellows are installed the manufacturer shall visit the site and inspect the final installation prior to cold pressure testing.
j. Lateral expansion joints are sometimes also called articulated or fully articulated. Angular expansion joints are sometimes referred to as hinged. For larger lateral movements in two planes two gimbal expansion joints may be used instead of the lateral unit. Restrained expansion joints are not designed to support associated pipe work.
k. Unrestrained Expansion Joints

    i. Axial expansion joints shall only be used in positions where pressure thrust can be contained by adequate anchor points contained by the building fabric. Recommended guide spacings and tolerances as described in Engineering Appliances "Guide to the use of Expansion joints" are critical and must be strictly adhered to.
    ii. Axial expansion joints shall be as manufactured by Engineering Appliances Limited their type EA01, EA02EA04, EA06, EA07, EA08, EA15 and EA16 or equivalent approved.
    iii. Axial expansion joints are not restrained and will exert a pressure thrust. This load can be very high and needs to be contained by suitable anchors. Comply with BS 13480.

E. Restrained Expansion Joints

a. Restrained expansion joints shall be used as an offset type either by using lateral or angular expansion joints to compensate for thermal expansion or building movement. The expansion joint restraints shall be designed to absorb the full pressure thrust of the expansion joint convolutions.

b. Lateral expansion joints shall be of the thick wall spirally wound multi-ply construction and fitted with threaded tie bars and low friction self-lubricating hemispherical nuts, allowing movement in two planes.
c. Angular expansion joints shall be of the thick wall spirally wound multi-ply construction and be used in pairs or threes. All hinge pins shall be PTFE coated to reduce friction and prevent corrosion. For movement in two planes Gimbal Expansion joints shall be used in pairs or in combination with one Angular Expansion joint. All hinge pins shall be PTFE coated to reduce friction and prevent corrosion.

F. Pipe Line Anchors and Guides

Refer section 2.9 for Pipeline anchors and guides.

G. Service crossing building expansion joints

a. At points where services cross the building expansion joints flexible connections, compensators, or expansion joints shall be provided to accommodate the building movement within the services installation.
b. Brackets and supports each side of the flexible joint shall be so arranged that services crossing the building expansion joint remain symmetrical and correctly aligned.

H. Flexible connections

Refer Section 2.10 for details.

12.6 Execution

A. Install pipe work so that stress is kept below the maximum permissible design stress as given in the appropriate pipe work standard.
B. Prior to installation, submit to the consultant for approval the exact locations and working drawing details including magnitude and direction of thrusts of all expansion joints, guides, anchors and other associated equipment.
C. Connect to items of plant and equipment in such a way that no stress is placed on the equipment or its connections.
D. Do not use branch connections as anchor points.
E. Wherever possible, cater for expansion and contraction by the inherent natural flexibility of the service pipe work. Where the use of inherent natural flexibility is not practicable, supply, install and connect expansion joints into the pipe work installation.
F. Install expansion joints in full accordance with the manufacturer's recommendations and instructions.
G. Prior to commencement of the installation, the contractor must agree with the expansion joint manufacturer to visit site to ensure his guidelines for selection and installation are adhered to. And that the anchors and guides are correctly positioned to ensure that the expansion joints function as intended. During system installation and just prior to application of heat onto the systems, the expansion joint manufacturer is to visit site to check that the installation is installed as designed and a Certificate of Compliance issued.
H. Install expansion joints with a cold pull (cold draw) equal to 50% of total expansion, except where expansion joints are supplied with cold pull already applied. Apply cold pull (cold draw) by means of flanges secured to the ends of pipe to be pulled together with long high tensile steel bolts and nuts. A check with the design figure for correct gap plus allowance for gasket thickness shall be made before final pull is made. A change to standard bolting shall be made when the gap is closed. Do not apply cold pull (cold draw) until the anchor installations have been completed and approved by the Consultant / PM.
I. Install guides on each side of axial expansion joints. The first primary guide shall be located within a distance of 4 pipe diameters or 300mm, whichever is the less. The second primary guide shall be located within a distance of 14 pipe diameters from the first guide.
J. Where axial expansion joints are positioned next to an anchor the maximum distance shall be 4 pipe diameters or 300mm, whichever is the less.
K. Provide intermediate guides for the remainder of the pipe work at appropriate intervals.
L. Ensure that guides are capable of withstanding a lateral force of at least 15% of the anchor force.
M. Ensure that the lateral movement of the pipeline permitted by the guide is no more than 2mm (±1mm) for pipes up to 100mm nominal size and 4mm (±2mm) for larger pipes, for the two primary guides next to the expansion joint. For intermediate guides the movement should be no more than 4mm (±2mm) and 8mm (±4mm) respectively.
N. Where pipe work up to 50mm size is fixed to solid walls, brackets may be of either the screw fixing type or long shank built-in type. For fixing to woodwork and lightweight partitions or walls, brackets shall be screw-on pattern and may be adjustable two-piece type.
O. Brackets for mild steel pipe work shall be mild steel or malleable iron. Brackets for copper pipe work shall be brass or gunmetal.
P. Obtain approval from the Consultant/Project Manager for any fixings to structural concrete or structural steel work.
Q. Fixings to the building structural element shall generally be by "Redheads", rawlbolts clamps adaptors or similar approved heavy fixings and white metal crawl plugs or approved plastic type plugs for light loads. Drilling of structural steelwork shall not be used for pipe supports. Supports with backplate in floor screed shall not be used.
R. Pipe work shall be securely supported, singly or in groups, graded to levels required for venting and draining and having regard to the requirements for differential expansion, anchors and guides and thermal insulation sizing.
S. Pipe work exposed to view shall have approved brackets or clips of neat appearance, screw fixed to the wall at intervals to give uniform spacings and neat appearance.
T. Non-ferrous clips and rollers shall be used on copper pipes or if steel clips are used lead packing sleeves shall be fitted between pipe and clip.
U. Mains in ducts shall be supported on rollers and chairs using fabricated mild steel brackets (painted) or galvanized channel sections with allowance for building-in or bolting-on to the surface of the duct wall.

V. Pipes at ceiling level or in roof spaces shall be suspended from rods or straps using adjustable mild steel hangers with swinging joints or purpose-made angle iron cradles or other steel sections. Clips shall be used on cold pipes with rollers and chairs on hot pipes and where expansion cannot be readily taken upon hanging brackets.

W. Exposed external steel brackets shall be fabricated then hot dipped galvanized before erection, unless otherwise specified.

X. Allowance for the fitting of pipe covering protection saddles specified shall be made at the support positions on mains that require continuous unbroken weatherproof or vapour proof seal finish, as in the case cold water pipes. Where required, fit load-bearing insulation at supports at the time of erecting this pipe work.

Y. Pipe work of 65mm size and larger subjected to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise agreed with the client.

Z. Hangers for horizontal pipe work at high level shall be supported from mild steel angle or channel sections or approved proprietary devices, suitable for building-in or otherwise securing to the structure. Adjustable mild steel hangers shall be used. Drop rods shall not be less than 13mm diameter. Pipe rings shall be of malleable cast iron or fabricated steel, made in halves and secured by bolts or screws. Alternatively, malleable iron hinged pipe rings may be used, but calliper hooks will not be permitted.

AA. Pipe work supports shall be arranged so that minimum stress is imposed upon the pipelines. Provide additional supports on either side of pipe work ancillaries and equipment such as valves, strainers, and heating coils and other pipeline mounted equipment. It is important to ensure that all materials used for pipe work supports are compatible with the pipeline materials

BB. Installation of Flexible Grooved end expansion joints

CC. Install in accordance with OEM Manufacturers instruction manual.

DD. A OEM Factory trained field representative shall provide on- site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review to ensure contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).All mild steel supports and channels shall be replaced with GI or mild steel with Zinc coating

EE. Install expansion joints of sizes matching sizes of piping in which they are installed.

FF. Install packed-type expansion joints with packing suitable for fluid service.

GG. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

HH. Install rubber packless expansion joints according to FSA-NMEJ-702 "Rubber Flanged Non-Metallic Expansion Joint. Installation, Maintenance and Storage"

II. Install grooved-joint expansion joints to grooved-end steel piping.

13. Testing And Commissioning

13.1 Summary

A. Employ the services of an independent specialist commissioning subcontractor to programme commission and collate test results.
B. The Contractor shall provide skilled technicians/engineer to commission the plant and associated controls to the satisfaction of the Owners representative.
C. Provide all necessary attendance to operate and maintain the plant and equipment during the commissioning period as required suiting the needs of the specialist commissioning contractor.
D. The technicians/ engineers will be required to demonstrate the correct procedures in starting and stopping the plant, running the various items of equipment under automatic and manual control and the correct maintenance of the plant.
E. This section provides a framework for the testing, regulation and commissioning procedures to be employed.
F. The scope of the works in this section may be divided into three stages:
   a. Pre-installation stage
   b. Installation stage
   c. Commissioning stage
G. Final approval of commissioning of the System / equipment is subjected to clearance of local municipal corporation, CFO & commissioning consultant.
H. The repetition of any test or commissioning shall be done if warranted by the Statutory Authority.

13.2 Scope of Works

A. Pre-Installation Stage

   a. Ensure that sufficient valves, test points, dampers etc. are incorporated and correctly located to allow satisfactory testing, regulating and commissioning.
   b. Ensure that all provisions for commissioning are included in the working drawings prior to being sent to the Owners representative.
   c. Produce an agreed programme and method statements for the commissioning works for approval by the Owners representative.

B. Installation Stage

   a. Undertake all tests and collate and witness all tests.
   b. Ensure that all water systems have been properly cleaned, flushed, filled and vented.
   c. Ensure that all air distribution systems have been properly cleaned and checked.
   d. Prepare method statements for the commissioning of each system.
   e. Attend the manufacturer's / supplier's works for performance tests on all major items of plant and equipment including, but not limited to, the following:
      i. Fire pumps
      ii. FA system
      iii. Fire proofing/Stopping
   f. Collate all satisfactory test certificates for inclusion in the O&M manuals. Any plant or equipment that fails to meet the specified duty shall require to be replaced unless given authorization to do otherwise by the Owners representative.

C. Commissioning Stage

   a. Commission the works in accordance with the commissioning programme.
   b. Independently retest 10% of the electrical tests on all power and lighting circuits. Should the tests indicate an unacceptable level of error the whole system shall be re-tested.
   c. Witness and accept the commissioning of all specialist systems by the manufacturers / suppliers including, but not limited to the following:
      i. Fire protection systems
      ii. Fire alarm systems
      iii. Fire proofing.
   d. Collate all testing and commissioning records for inclusion in the O&M manuals.

e. Demonstrate, to the satisfaction of the Owners representative, that the systems are properly regulated and set to work.
f. Ensure that all detectors, etc. are properly adjusted and calibrated and that all controls conditions are achieved. Ensure that all systems operate to their design intent including all safety, alarm and control scenarios.

13.3 Quality Assurance

A. The work content and contract programme shall be based on the recommended procedures set out in the following documents (hereafter called the "commissioning documents"):

a. CIBSE Technical Memoranda:
b. TM17: Building Services Maintenance Management
c. BSRIA Documents:
d. BG1/2007: Operating and Maintenance Manuals for Building Services
e. BG2/2010: The Commissioning of Water Systems
f. AG1/2001.1: Pre-Commissioning Cleaning of Water Systems
g. AH3/92: Installation Maintenance and Commissioning of Fire and Security Systems
h. BG11/2010: Commissioning Job Book
i. NFPA Documents:
j. NFPA-13: Standard for installation of Sprinkler system
k. NFPA-14: Standard for installation of Standpipe & hose system
l. NFPA-20: Standard for installation of Stationary pumps for fire protection

B. Undertake commissioning in accordance with all manufacturer's literature relating to the plant and equipment installed as part of the engineering services installations.

13.4 Submittals

A. Submit the following at the appropriate time for comment and review:

a. Commissioning programme
b. Commissioning method statements
c. Testing and commissioning record sheets

B. Commissioning Programme

a. Within 2 weeks of appointment, provide a commissioning programme indicating the various activities and associated time periods required for the commissioning of the services. Agree this programme with the Owners representative and other relevant parties for incorporation into the main contract programme.
b. Take into account the contract programme and identify The following periods:

c. Pre-commissioning of water systems, electrical systems and HVAC System.

i. Power on date
ii. Dynamic commissioning
iii. Performance demonstrations and witnessing
iv. Operation and maintenance manual
v. Handover and employer's training

d. The following for each system:

i. Earliest and latest start date
ii. Finish date
iii. Duration to complete task (in days)

e. The following milestones:

i. Completion of static tests (pipe work, ductwork and electrical tests)
ii. Period required for dynamic testing (balancing and integrated tests)
iii. Power on to the MCCs
iv. Cooling on to the building
v. Demonstration to the Owners representative.
vi. Submittals required to show building regulation compliance

vii. Employers training
viii. Practical completion

f. Ensure that all systems are shown separately and not grouped together, e.g. "MCC's" is not acceptable but "MCC1", "MCC2", etc. would be acceptable.
g. Each system shall be separately identified and all interdependencies shall be shown.
h. Indicate the period required for the fully integrated testing of the systems to demonstrate that all systems interact with each other in the correct manner. This is particularly relevant to fire alarm, BMS and any life safety items with hard-wired interlocks.
i. Carry out a major review and update of the commissioning network at monthly intervals thereafter, and if necessary revise and amend his programme to suit the progress of the works. Copies of the programme and network analysis together with any revisions shall be issued to the Owners representative for comment.

C. Commissioning Method Statements

a. Within 30 days of appointment, provide method statements for each system and sub-system for the whole works listing all the activities in complete detail for comment and approval by the Owners representative.
b. Identify the following:

i. Specific details of the task
ii. Responsibilities of each party
iii. Any pre-requisites or milestones
iv. Interfaces with other systems
v. Documentation proposed
vi. Health and safety considerations
vii. Demonstration procedures

c. No commissioning shall take place without an approved method statement being in place.

D. Testing and Commissioning Record Sheets

a. Submit testing and commissioning record sheets to the Owners representative for comment. Agree information and sheets to be used with the Owners representative Record information on agreed documentation and submit to the Owners representative for comment and review.

E. Co-Ordination

a. Co-ordinate the commissioning works with the works of others and assist as necessary.
b. Indicate on the drawings where access is required into ceiling voids and partitions and ensure that these points are available at the start of the commissioning works and are not closed up until the commissioning works are complete.

13.5 Factory Tests

The following tests shall be performed in the presence of the Owners Representative.

a. Main Switchboard
b. Inspection of switchboard including wiring, electrical and mechanical connections.
c. Mechanical tests.
d. Primary and secondary injection tests to commission and calibrate all measuring, protection and control circuits and associated components.
e. Continuity and dielectric tests.
f. Power frequency and pressure test.
g. Functional check of all control wiring.
h. Valves, Cocks ,Fittings & Fire Fighting Accessories
i. Type-Test' and approval certificate for pressure test and compliance with the regulations laid down by the local Authority / Standards / Project Manager.
j. All major equipment's should be factory tested and contractor shall allow for factory visit for witnessing of client & consultant.
k. Fire pumps

13.6 On-Site Testing And Commissioning - General.

A. The contractor shall allow sufficient time prior to completion of contract work, the Contractor shall liaise and submit for the client's approval a detailed programme for conducting on-site acceptance tests and commissioning.
B. The Contractor shall start up, operate, test and adjust the systems in accordance with the agreed programme. The setting shall be supervised by the manufacturer's representative, who shall remain on site until the equipment is operating satisfactorily and accepted by the Client. The Contractor shall advice and co-ordinate with the manufacturer's representatives so that all testing is carried out according to the agreed programme.
C. The whole installation shall be given the following tests to bring the systems into running order. The Client shall be given reasonable notice together with a copy of recorded test results, generally not less than seven (7) days, regarding the nature of tests, the time and location. Acceptance tests will only be witnessed by the Client when the submitted tests results are found satisfactorily.
D. All instruments, tools, material and labour required to perform these tests shall be provided by this Contractor.
E. Before the tests are carried out, the Contractor shall remove connected equipment and components which are liable to damage under test, and shall provide and fix all the necessary gauges, blanking flanges, etc.
F. Prior to the system start-up, the following inspection, tests and pre-commissioning treatment shall be carried out by the Contractor:
G.
H. Tanks and Level Switches

   i. Check sides and edges of sectional tanks for distortion. The tanks shall be thoroughly cleaned with water and drained.
   ii. Also, the level switch shall be simulated for the various cut-in and cut-out settings.

I. Pressure Switches.

   i. The testing equipment arrangement for pressure switches and pressure gauges shall be as shown on the approved shop drawings.
   ii. The pressure gauges to be tested shall be connected as shown on the approved shop drawing in lieu of the pressure switch. The gauges to be tested shall be regarded acceptable when the pressure readings of all three gauges are the same throughout the jacking pressure range varied by applying the hand pump.

J. Hydrostatic Tests

   i. All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate, are conducted.
   ii. The hand-jacking pump shall be applied to increase the system pressure to 1.5 times the working pressure. The pressure shall be maintained for a period not less than 24 hours.
   iii. Where any section of pipe work or equipment is found to be unable to withstand the maximum pipe work test pressure, it shall be isolated during the pipe work test then that section of pipe work or equipment shall be made good and re-tested at the appropriate test pressure.
   iv. The working pressure for various systems shall be estimated by contractor and submit for approval to the consultant.
   v. All valves and accessories etc should be factory tested at 1.5 times of its design working pressure

K. Drains

   i. House drains shall be hydrostatically tested to a water head of 1.2 m at the high end and not more than 2.4m at the low end and shall show no appreciable loss of water after elapse of two hours.
   ii. In every test, water used shall be left in the pipes until they are covered with earth or other trench filling material to a depth of at least 1 m over the top of pipes and until permission is given by the client/consultant for the water to be released. If after the client/consultant has approved the sewer or pipeline and has given permission for the trenches to be refilled the pipes become damaged and loses water from any cause and/or admit subsoil water, the Contractor shall uncover the pipes and make good the defect and the pipes retested as before and all at the Contractor's expense.

L. Cleaning, Flushing and Pre-Treatment

i. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.
ii. All strainers shall be inspected and cleaned out or replaced.
iii. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:
   - Remove oil, grease and foreign residue from the pipe work and fittings.
   - Pre-condition the metal surfaces to resist reaction with water or air.
   - Establish an initial protective film

iv. After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
v. Details and procedures of the pre-treatment shall be submitted to the client/consultant for approval.

M. Electrical Tests

i. Electrical tests shall comply with the current edition of IEE regulations and requirements enforced by Local Authorities.
ii. Electrical insulation tests earth electrode resistance test and cost amenity test shall apply to bus bars, isolators and other equipment and wiring where applicable.
iii. A 500V DC instrument shall be used to check the insulation resistance. The reading shall not be less than 1 mega-ohm in all instances.
iv. Function simulation tests shall be performed to ensure that the systems have been installed to the control requirements as described in the Specification therein.

N. Pump Drives

i. The direct coupling of the pump drives shall be dismantled before the pump motor control panel is energized.
ii. The Contractor shall demonstrate to the client/consultant of acceptable clearances of the coupling alignment for ensuring satisfactory power transmission.
iii. The coupling shall not be re-mated again till the correct motor rotation has been demonstrated with power drawn from the energized pump motor control panel.

O. Pump Operating Test

i. The Contractor shall ensure to the satisfaction of the client / consultant that the installation or portion thereof which has been set to work complies with all requirements including the following:
ii. That the plant and apparatus shall be of robust construction and of capacity for the duty specified.
iii. That all valves, switches, controls and the like are properly regulated and capable of proper operation and in the case of valves are capable of being shut-off.
iv. That all apparatus shall be silent.
v. That all instruments are correctly calibrated and read accurately.
vi. That all services are tested in accordance with the details of the relevant clauses of this Specification.

13.7 Statutory Authorities Tests and Inspections

A. As and when notified in writing or instructed by the client/ consultant, the contractor shall submit shop drawing and attend all tests and inspections carried out by Local Authorities and other Statutory Authorities shall forthwith execute free of charge any rectification work ordered by the client/ consultant as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.
B. 2. The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.
C. 3. The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the client/consultant for checking before submission. The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The client/consultant

may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

D. 4. The Contractor shall notify the client/consultant at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the client/consultant without delay.

13.8 Preliminary Commissioning Checks

A. Ensure that all equipment & system is thoroughly cleaned, lubricated and checked for serviceability before setting to work. Particular attention is drawn to the removal of building debris from the pipe work systems.
B. Special attention is drawn to the need for thoroughly flushing out all pipe work systems to ensure that all foreign matter is removed.
C. All automatic controls and safety devices shall be inspected and checked for service ability before the working fluid or electricity is applied to the system.

13.9 Commissioning

When the various installations have been completed and the preliminary commissioning checks carried out, the Contractor shall set to work, regulate and calibrate all system in the entire installation. Special attention shall be paid to the following items:

A. That all valves, switches, controls, etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.
B. That all apparatus is silent in accordance with the requirements of this Specification.
C. That all instruments are correctly calibrated and read accurately.
D. That all services are tested in accordance with the details in the relevant clauses of this Specification.
E. Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked

13.10 Final Acceptance Tests

A. Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the client/consultant.
B. Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.
C. Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.
D. Final approval of commissioning of the equipment is subjected to clearance of commissioning consultant and the Chief Fire officer, Mumbai.

13.11 Rejection of Plant

A. Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the client/consultant either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the client/consultant so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/client/consultant.
B. After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Employer.

13.12 Handing Over Of Documents

A. All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Client and all testing and commissioning **ORIGINAL** documents shall be handed over to the Client.
B. The Contractor shall also hand over all **ORIGINAL** maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Client.

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