SCOPE OF WORK

Works Requirements / Employer's Requirements (Civil, Architectural, Structural, Electrical, PHE, HVAC and Fire-fighting Works)

A. GENERAL GUIDELINES

The general character and the scope of the Work includes Site clearance, Procurement of materials, construction and hand over of Commercial complex at Polo Junction.

1. Construction of Commercial complex at Polo:

SSCL, under the Smart City Mission of the Government of India, has proposed to construct a Commercial complex at Polo Junction along the Umkhrah river and besides the newly built Vendors market.

The scope of work includes all aspects of the construction and commissioning of the Commercial Complex including Site clearance, excavation, Substructure, Superstructure, Finishing, Truss work, Tensile works, Mechanical, Electrical & Plumbing (MEP) works including installation of Lifts, escalators, Sewage treatment (STP) plants, etc. and external development with landscaping and hardscaping works. The site will be provided free of any hindrances/ encumbrances to the successful bidders, i.e., the existing structures will be cleared and provided by the employer.

The building has to be constructed as per the approved Architectural/Structural/Electrical drawings. Inspection and testing of works shall be conducted by the employer as per latest CVC guidelines. Contractor has to follow the quality norms of IS Code. Responsibility of quality of work and materials solely lies on the contractor which shall be checked by PMC and SSCL in that order. Decision of SSCL shall be final and binding in this regard.

Note-Details and drawings given in this document are for information purpose only and successful bidder shall undertake confirmatory surveys for accuracy and completeness of data. It is in scope of successful Bidder to undertake Site surveys as per requirements, Geotechnical investigations/Engineering Surveys, hydrological investigations, Underground Utility Surveying of the site for shifting and creating new, obtaining all required approvals from the relevant authorities. The successful bidder shall prepare 'As Built Drawings' after execution depicting the exact construction carried out on site, in soft and hard copy format.

The Civil works is part of Contract as given in the following but not limited to:

(a) All the civil works mentioned in this section has to be read in conjunction with the civil scope of works and BOQ. No duplication is envisaged.

(b) Site clearing and Levelling of the Complete Area, earmarked for the work.

(c) All materials including cement and steel required for the civil and Electrical work is in the scope of the contractor.

(d) The scope of civil works for bidder covers engineering, supply of labour & materials, transportation, and construction of entire civil engineering works.

(e) The scope of work of bidders is not limited to the major item of civil works as elaborated above but includes all civil works required for the successful completion & commissioning of Mechanical, Electrical, Plumbing, (MEP) works without any extra cost.

(f) The scope of work also includes sampling & testing of construction material on the specimens taken during execution of the work. The testing shall be performed by a NABL accredited lab, approved by the engineer in charge.

(g) Site office, cement & other construction material storage godown and fabrication yard for reinforcement, inserts etc. shall be constructed by the contractor at his own cost.

(h) All construction equipment required for execution of the work shall be arranged, procured & hired by successful Bidders at his own cost along with operations, skilled & semiskilled personnel. The successful Bidders shall also furnish a list of construction equipment /staff deployment.

(i) Construction of temporary sheds/ barricades for the temporary store, site office as well as safety and security of equipment shall be in the successful Bidder's scope.

2. TECHNICAL SERVICES

The following technical services shall be in the scope of the Bidder:

(a) Liaison with Central/ state Government Departments/ MePDCL / CEIG or any other authorities concerned on for matters like work entrustment, vendor approvals, drawing approvals, PTCC, TA&QC approvals and any other matters connected with the work and gets the approvals within the specified time for successful completion of work for all matters including obtaining approved designs & drawings, and commissioning of the Project including all incidental costs incurred thereon. Shillong Smart City Limited, however, will provide only all the required administrative supports to the contractor in this regard and also would reimburse to the Contractor all the statutory charges paid to the departments like MePDCL/ MECL/CEIG on production of official receipts thereon.

(b) Liaison with Meghalaya State Electricity Board for approval of technical specifications, materials, inspection, quality control, testing and commissioning of newly installed equipment, total responsibility for the completeness of the project including erection testing and commissioning.

(c) The successful tenderer shall take the responsibility of obtaining all statutory clearances from all statutory bodies, on behalf of the Employer. (However, fee to be reimbursed by the Employer on production of documentary evidence)

(d) Working drawing and layout engineering of Electrical and Civil & structural work.

(e) Submission of QAP and Test certificates.

(f) Arranging inspection of the materials by the employer/ employer's representative

(g) Contractor shall design the proposed formworks. Design and drawings of the formwork to be submitted engineer in charge for approval before implementation at site.

(h) Submission of As Built drawing after commissioning of project.

B. All materials /machinery/items used in the subject package shall be provided according to specification given herein. All electrical items shall be supplied from the "List of Preferred makes". Prior approval from Employer shall be taken for the equipment/ items not available in the list.

C.

3. PARTICULAR SPECIFICATIONS

1. Flooring works – Pattern of laying and the type of tiles (glossy / matt / anti – skid / satin) shall be as per the final architectural drawing. The contractor shall provide spacers in between tiles to fill epoxy / grout filling.
2. All spoil from the project (demolition materials / construction waste / rejected unusable material) shall be disposed off to an approved location.
3. The contractor shall ensure perfect dimensions as per the drawing for window openings, door openings, levels of sill and floor etc during construction. Any deviations from the drawings shall be rectified at no extra cost.
4. The Technical specifications, code of practice etc. Shall be referred in accordance with CPWD Specifications and work shall be executed accordingly.
5. Items which are not covered under CPWD Specification shall be carried out as per relevant IS Specifications or as per manufacturer's specifications or as directed by the Engineer-in-charge.
6. All the measurements shall be as per the latest edition of B.I.S.

D. GENERAL SCOPE OF WORK- CIVIL

1.1 Description of Work Site

4. Shillong Smart City Limited (SSCL) is implementing the Construction Commercial complex at Polo, under Area Based Development.

5. The location of the work and the general site particulars are shown in the Site Layout enclosed in the tender drawings.

1.2 Standard Specifications

a. The work in general shall be carried out as per CPWD specifications, 2009 (Volume I to II). Additionally, the specifications for individual items given in the document shall be read in conjunction with CPWD specifications.

b. For the items not covered under the specifications as stated above, the work shall be done as per relevant IS Codes, latest publications with correction slip.

c. For the items not covered under any of the specifications stated above, the work shall be executed as per Manufacturer's specifications/ General Engineering Practice and/or as per direction of Engineer-in-charge.

d. In the absence of any definite provisions or any particular issue in the aforesaid specifications, reference is to be made to the latest codes and specifications of BIS, IRC, BS, ASTM, EURO codes and AASHTO in that order. Where even these are silent, the construction and completion of works shall confirm to sound engineering practice as approved by Engineer-in-Charge. In case, if any dispute arises out of interpretation of the above, the decision of the Engineer-in-Charge shall be final and binding on the Contractor.

e. Wherever reference is made in the Contract to specific standard codes to be met by the materials, plants and other supplies to be furnished and work performed and tested, the latest edition or revision of the relevant codes in effect shall apply, unless

otherwise explicitly stated in the contract. Wherever such standards and codes are national or related to a particular country of region, other internationally recognized standards which ensure a substantially equal or higher performance than the standards and codes specified will be accepted subject to the Engineer-in Charge's prior review and written approval. Differences between standards must be fully described in writing by the contractor and submitted to the Engineer-in-Charge at least 15 days prior to the date when contractor desires the Engineer-in-Charge's approval.

If the Engineer-in-Charge determines that such proposed deviation do not ensure substantially equal performance, the contractor shall comply with the standards specified in the documents.

These Specifications contained herein shall be read in conjunction with other tender documents.

I. The Work shall be carried out in accordance with the "Good for Construction" drawings and designs as would be issued to the Contractor by the Engineer duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Engineer's signature and stamp. Similarly, the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer in writing.
6.

II. The work shall be executed and measured as per metric units given in the Schedule of Quantities, drawings etc. (FPS units where indicated are for guidance only).

III. Absence of terms such as providing, supplying, laying, installing, fixing etc in the descriptions does not even remotely suggest that the Contractor is absolved of such providing, supplying etc unless an explicit stipulation is made in this contract. The Owner shall bear no costs of materials, labour, equipment, duties, taxes, royalties etc.

IV. The specifications may have been divided into different sections / sub-heads for convenience only. They do not restrict any cross-references. The Contractor shall take into account inter-relations between various parts of works/trades. No claim shall be entertained on the basis of compartmental interpretations.

V. The classification of various items of works for purposes of measurements and payments shall be as per bills of quantities (BOQ). Except where distinguished by BOQ, the rates apply to all heights, depths, sizes, shapes and locations. They also cater for all cuts and wastes. No floor wise separation shall be made for the rates. Likewise, all heights of centring, shuttering, staging, formwork and scaffolding, trusses and erection methods are covered by the rates including multistage propping for heights greater than one floor as per drawings.

1.3 Abbreviations

ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
BS	British Standard
CPWD	Central Public Works Department
DIN	Deutsches Institut für Normung e.V.
IRC	Indian Road Congress
IRS	Indian Railway Standards
IS	Indian Standards
JIS	Japanese Industrial Standard

MORTH	Ministry of Road Transport and Highways

1.4 Reference to the Standard Codes of Practice

The contractor shall make available at site all relevant Codes of practice as applicable.

1.5 Contractor to Provide

The Contractor shall provide and maintain at site throughout the period of works the following at his own cost and without extra charge, except for the items specified in the Bill of Quantities the cost being held to be included in the Contract Rates:

i. General works such as setting out, site clearance before setting out and on completion of works. All weather approach roads to the site office should also be constructed and maintained in good condition.

ii. All labour, materials, plant, equipment and temporary works, Overhead charges as well as general liabilities, obligations, insurance and risks arising out of GCC, required to complete and maintain the works to the satisfaction of the Engineer.

iii. Adequate lighting for night work, and also whenever and wherever required by the Engineer.

iv. Temporary fences, barricades, guards, lights and protective work necessary for protection of workmen, supervisors, engineers, General public and any other persons permitted access to the site. Contractor shall provide proper signages as directed.

v. All fences, barricade shall be painted with colour shades as specified by the Engineer. The barricading should be of adequate height to ensure visual obstruction of work from public view.

vi. All equipment, instruments, labour and materials required by the Engineer for checking alignment, levels, slopes and evenness of surfaces measurements and quality etc.

vii. Design mixes and testing them as per relevant clauses of specifications giving proportion of ingredients, sources of aggregates and binder along with accompanying trial mixes. Test results to be submitted to the Engineer for his approval before adoption on works.

viii. Cost of Preparation and compliance with provision of a quality assurance control programme. Cost of safeguarding the environment.

ix. A testing laboratory as specified by the Engineer equipped with the following minimum apparatus, materials and competent trained staff required for carrying out tests, as specified in the relevant sections of the specifications: -

a) One Set of standard sieves for testing grading of sand with mechanical sieve shaker.

b) Sieves with openings respectively of 4.75mm, 10mm, 20mm, 25mm, 30mm and 40mm for testing and grading of aggregates.

c) Weighing Balance of capacity up to 10 Kg. reading up to 5 gm.

d) Electric Thermostat controlled oven and pans for drying of sand and aggregates.

e) Glass measuring flasks of 1/2, 1 litre & 2 litre capacity.

f) Flask for determining moisture content of sand.

g) Slump cone with rod and V B Apparatus, flow table to measure slump or DIN Specifications.

h) Apparatus to measure permeability of concrete as per Appendix 1700/II of MOST

   a. Specifications.

i) Minimum 24 Nos. steel moulds for 150mm x 150mm x 150mm concrete test cubes. It may be necessary to provide more steel cube moulds depending upon concreting programme.

j) 25mm dia vibrator for compaction of concrete in test cubes and also vibrating table.

k) Concrete cube testing machine of 200 tonnes capacity with 3 dial gauges electrically operated.

l) Work benches, shelves, desks, sinks and any other furniture and lighting as required by the Engineer.

m) Abrasion Flakiness & Impact testing Equipment for testing coarse aggregate.

n) Silt Testing Equipment.

o) Any other equipment specified by Engineer.

x. Quality Assurance & Quality Control:

a) The work shall conform to high standards of design and workmanship shall be structurally sound and aesthetically pleasing. The Contractor shall conform to the Quality standards prescribed, which shall form the backbone for the Quality Assurance and Quality Control system.

b) At the site, the Contractor shall arrange the materials, their stacking/storage in appropriate manner to ensure the quality. The Contractor shall provide all the necessary equipment and qualified manpower to test the quality of materials, assemblies etc., as directed by the Engineer. The tests shall be conducted at specified intervals and the results of tests properly documented. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of the surfaces.

c) The Engineer shall be free to carry out such tests as may be decided by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor may provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

The test shall be conducted at the Site laboratory that may be established by the Contractor or at any other Standard Laboratory selected by the Engineer.

The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of the Contractor failing to arrange transportation of the samples in proper time the Engineer shall have them transported and recover two times the actual cost from the Contractor's bills.

All testing shall be performed in the presence of Engineer. Testing may be witnessed by the Contractor or his authorized representative if permitted by the Test House. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, all equipment including the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged, and the Engineer's approval obtained prior to starting of the particular item of work. This shall however, not relieve the Contractor of his responsibilities. All materials, which do not confirm to these specifications, shall be rejected and shall be removed from the site immediately. The Engineer shall have the powers to cause the Contractors to purchase and use materials from any particular source, as may in the Engineer's opinion be necessary for the proper execution of work.

1.6 Dimensions

Figured dimensions on drawings shall only be followed and drawings to a large scale shall take precedence over those to a smaller scale. Special dimensions or directions in the specifications shall supersede all others. All dimensions shall be checked on site prior to execution.

The dimensions where stated do not allow for waste, laps, joints, etc. but the Contractor shall provide at his own cost sufficient labour and materials to cover such waste, laps, joints, etc.

The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct, but the Contractor should verify them for himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or the description of the ground levels or strata turning out different from what was expected or shown on the drawings.

1.7 Setting out of Works

The Contractor shall set out the Works indicated in the Conditions of Contract. The Contractor shall provide suitable stones with flat tops and build the same in concrete for temporary benchmarks. All the pegs for setting out the Works and fixing the levels required for the execution thereof shall, if desired by the Engineer, likewise be built in masonry at such places and in such a manner as the Engineer may direct. The Contractor shall carefully protect and preserve all benchmarks and other marks used in setting out the works. The contractor will make overall layout of complete work and get it checked from engineer. The cost of all operations of setting out including construction of benchmarks is deemed to be included in the quoted rates as per Bill of Quantities.

(a) All the survey work and levelling work shall be carried out using total stations with one second accuracy. The levelling work may also be carried out using Auto level.

(b) The triangulations point given by SSCL before start of work shall be maintained during execution and handed over back to SSCL after completion of work.

1.8 Materials

1.8.1 Source of Materials

It shall be the responsibility of the contractor to procure all the materials required for construction and completion of the contract. The contractor shall indicate in writing the source of materials well in advance to the Engineer, after the award of the work and before commencing the work. If the material from any source is found to be unacceptable at any time, it shall be rejected by the Engineer and the contractor shall forthwith remove the material immediately from the site as directed by the Engineer.

1.8.2 Quality

All materials used in the works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Engineer and shall comply strictly with the tests prescribed hereafter, or where tests are not laid down in the specifications, with the requirements of the latest issues of the relevant Indian Standards.

1.8.3 Sampling and Testing

All materials used in the works shall be subjected to inspection and test in addition to test certificates. Samples of all materials proposed to be employed in the permanent works shall be submitted to the Engineer at least 45 days in advance for approval before they are brought to the site.

Samples provided to the Engineer for their retention are to be labelled in boxes suitable for storage. Materials or workmanship not corresponding in character and quality with approved samples will be rejected by the Engineer.

Samples required for approval and testing must be supplied sufficiently in advance of required quality and number to allow for testing and approval, due allowance being made for the fact that if the first samples are rejected further samples may be required. Delay to the works arising from the late submission of samples will not be acceptable as a reason for delay in completion of the works.

Materials shall be tested before leaving the manufacturer's premises, quarry or resource, wherever possible. Materials shall also be tested on the site and they may be rejected if not found suitable or in accordance with the specification, notwithstanding the results of the tests at the manufacturer's works or elsewhere or test certificates or any approval given earlier. The contractor will bear all expenses for sampling and testing, whether at the manufacturer's premises at source, at site or at any testing laboratory or institution as directed by the Engineer. No extra payment shall be made on this account.

1.8.4 Dispatch of materials

Materials shall not be dispatched from the manufacturer's works to the site without written authority from the Engineer.

1.8.5 Test certificates

All manufacturer's certificates of test, proof sheets, etc showing that the materials have been tested in accordance with the requirement of this specification and of the appropriate Indian Standard are to be supplied free of charge on request to the Engineer.

1.8.6 Rejection

Any materials that have not been found to conform to the specifications will be rejected forthwith and shall be removed from the site by the Contractor at his own cost within two weeks or as instructed by the Engineer.

The Engineer shall have power to cause the Contractors to purchase and use such materials from any particular source, as may in his opinion be necessary for the proper execution of the work.

1.8.7 Storing of Materials at site

All materials used in the works shall be stored on racks, supports, in bins, under cover etc as appropriate to prevent deterioration or damage from any cause whatsoever to the entire satisfaction of the Engineer.

The storage of materials shall be in accordance with IS 4082 "Recommendation on stacking and storage or construction materials on site" and as per IS 7969 "Safety code for handling and storage of building materials".

The materials shall be stored in a proper manner at places at site approved by the Engineer. Should the place where material is stored by the Contractor be required by the Employer for any other purpose, the Contractor shall forthwith remove the material from that place at his own cost and clear the place for the use of the Employer.

1.9 Water

i. Water from approved source
Potable water only shall be used for the works. Contractor shall have his own source of water duly approved by Engineer. The water shall be free from any deleterious matter in solution or in suspension and be obtained from an approved source. The quality of water shall conform to IS 456.

ii. Storage
The Contractor shall make his own arrangements for storing water, if necessary, in drums or tanks or cisterns, to the approval of the Engineer. Care shall be exercised to see that water is not contaminated in any way.

iii. Testing

Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete for approval of the Engineer. No water shall be used until tested and found satisfactory. Cost of all such Tests shall be borne by the contractor.

1.10 Workmanship

All works shall be true to level, plumb and square and the corners, edges and arises in all cases shall be unbroken and neat. Any work not to the satisfaction of the Engineer or his representative will be rejected and the same shall be rectified or removed and replaced with work of the required standard of workmanship at no extra cost.

1.11 Load Testing on Completed Structures

During the period of construction or within the defect liability period the Engineer may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:

a) Results of compressive strength on concrete test cubes falling below the specified strength.
b) Premature removal of formwork.
c) Inadequate curing of concrete.
d) Over loading during the construction of the structure or part thereof.
e) Carrying out concreting of any portion without prior approval of the Engineer.
f) Honey combed or damaged concrete, which in the opinion of the Engineer is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.
g) Any other circumstances attributable to alleged negligence of the contractor which in the opinion of the Engineer may result in the structure or any part thereof being of less than the expected strength.

All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the Engineer, IS: 456 and as indicated hereunder. Such tests shall be carried out only after expiry of minimum 28 days or such longer period as directed by the Engineer.

The structure shall be subjected to a super-imposed load equal to 1.0 times the specified superimposed load assumed in the design. This load shall be maintained for a period of 24 hours before removal. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members as directed. The deflection due to the superimposed load shall be recorded by sufficient number of approved deflectometers capable of reading up to 1/500 of a cm and located suitably under the structure as directed by the Engineer.

The structure shall be deemed to have passed the test if the maximum deflection at the end of 24 hours of loading does not exceed the deflection given by the following expressions:

D = 0.001 L2/25 T, where,

D = max deflection due to imposed load only

L = span of the member under load test (the shorter span in case of slabs).

The span is the distance between centres of the supports or the clear distance between the supports plus the depth of the member, whichever is smaller. In case of cantilever, this shall be taken as twice the distance from the support to the end and deflection shall be adjusted for movement of the support.

T = depth of member.

If within 24 hours of the removal of the superimposed load, the structure does not recover at least

75% of the deflection under the superimposed load, the test loading shall be repeated after a lapse of

72 hours. If the recovery after the second test is less than 80% of the maximum deflection shown during the second test, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

In such cases the portion of the work concerned shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Engineer. However, such remedial measures shall be carried out to the complete satisfaction of the Engineer.

All costs involved in carrying out the tests (except integrity test for piles) and other incidental expense thereto shall be borne by the contractor regardless of the result of the tests. The contractor shall take down or cut out and reconstruct the defective work or shall make the remedial measures instructed at his own cost.

If the load testing is instructed on any ground other than mentioned in a) to g) as mentioned above, then the cost of the same shall be reimbursed if the result of the tests are found to be satisfactory.

In addition to the above load tests, non-destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the contractor at his own expense if so desired by the Engineer. Non-destructive testing of piles will be paid as per BOQ. Such tests shall be carried out by an agency approved by the Engineer and shall be done using only recommended testing equipment. The acceptance criteria for these tests shall be as specified by the testing agency or good engineering practice and as approved by the Engineer.

1.12 Structural Work

i. Unless specified, only controlled concrete with design mix and weigh batching is to be used for the work.

ii. Minimum cement content specified in CPWD specification 2009 (with upto date corrections slip) is purely from durability point of view. Larger content of cement shall have to provide if demanded by mix design.

iii. Provision of cement slurry to create bond between plain / reinforced concrete surface and subsequent applied finishes shall not be paid extra.

iv. Mix design using smaller aggregates of 10mm down shall also be done in advance for the use in the junction having congested reinforcement.

v. Procedure of mixing the admixtures shall be strictly as per the manufacturer's recommendations if not otherwise directed by the Engineer.

vi. All the water tanks and other liquid retaining concrete structures shall undergo hydro-testing. vii. Special benches shall be provided at site for stacking reinforcement bars of different sizes.

viii. Formwork for beams of RCC areas shall be designed in such a way that the formwork of the adjacent slabs can be removed without disturbing the props / supports of the beams.

ix. Wherever there are tension / suspended concrete members which are suspended from upper level structural members, the shuttering / scaffolding of such members at lower level shall have to be kept in place till the time the upper level supporting members gain minimum required strength. Cost of such larger duration of keeping in place the shuttering/scaffolding shall be deemed to be included in the price quoted for respective structural members.

x. Formwork is required for full height at all locations. Special precaution for such tall formwork shall be taken to ensure its safety. Extra costs for such formwork shall be deemed to have been included in the price quoted against relevant items.

xi. In the mobilization period, the contractor shall carry out expeditiously and without delay the following works:

a. Material testing and mix designs of concrete as contemplated in the specifications.

b. Setting up of full-fledged site laboratory as per the requirements of these specifications.

c. Any other pre-requisite items required for final execution.

d. Site office for the use of the Engineer staff.

e. Casting yard with full facilities.

xii. Casting yard to have following minimum facilities:

a. Casting beds as required.

b. All handling facilities for pre-cast elements.

c. Curing arrangements as required.

d. Stacking arrangements for pre-cast elements.

e. Storing of materials.

f. Proper drainage and approach roads.

1.13 Survey Works

The said work involves at the very start of work taking-over of reference point from the Engineer, establishment of control points, triangulation points, bench marks, grid layout for all the piers/column and other structures maintaining horizontal and vertical control within the permissible limits, incorporating changes (if any), submission of full data in the tabulation form and survey drawings including setting and layout of various works during the progress of work.

1.14 Barricading

The work covers barricading of the work site. The detailed scope of work is as follows:

i) Providing and installing the barricade of the design and type as shown in the typical sketch furnished as per the approved plan firmly to the ground and maintaining it during the progress of work.

ii) Dismantling of barricading and other temporary installations from the site and cleaning the site as per direction of Engineer upon completion and acceptance of work.

Measurement

The barricading including all the fixtures shall be measured as per relevant item in BOQ. (Payment of the item shall be made on monthly basis over contract period including extended period if any. No extra payment shall be made for the extended period if any. No extra payment will be made for any lateral shifted barricading required for satisfactory execution of work.

1.15 Finishing Works

1.15.1 Guarantees and Building Maintenance for Finishes

The Contractor shall guarantee and undertake to maintain and rectify the various components of the Civil Works for their successful performance for the periods as specified below. The Contractor shall indemnify the Engineer for a similar period against any damage to property and injury to persons on account of any defective work or maintenance carried out by the Contractor. The format and text of the Guarantee and the Indemnity Bond shall be as followed in CPWD or as approved by the Engineer.

a. Waterproofing for basements (which include raft, retaining walls, and expansion/separation joints in retaining walls) and roofs shall be guaranteed for 7 years. The waterproofing shall include all allied works on the roof such as concrete screed

and the China Mosaic roof finish/ stone cladding on the parapet between which the waterproofing treatment shall be sandwiched.

b. Waterproofing for the other areas such as toilets, kitchens, chhajjas etc. shall be guaranteed for 7 years. The waterproofing shall include all allied works on the slab etc. such as concrete/ mortar screeding, if any, floor finish between which the waterproofing treatment shall be sandwiched.

1.15.2 Responsibility for Shop drawings, Samples and Mock-ups

Approval of shop drawings, samples and mock-ups for the various components shall not absolve the Contractor of his responsibility of completing the work to the specifications, standards, tests for performance and guarantees given in these documents and to a quality of finish as desired by the Engineer.

1.15.3 Cleaning

Surfaces on which finishes are to be provided shall be cleaned with water jets or oil free compressed air or power tools with wire brushes and detergents all as approved by the Engineer.

1.15.4 Expansion bolts/ fasteners:

i. Unless specified otherwise all expansion bolts/ fasteners shall be fabricated from stainless steel sheet, strip or plate conforming to ASTM A 240 Gr 304 or bar to ASTM A 479 Gr 304 of approved make and design. The material of the bolt shall not cause any bimetallic corrosion with the reinforcing bars of the RCC/ brickwork or with any other fixings or doors or windows or skylights etc.

ii. For steel backings the fasteners shall be prevented from contact with other metals, which would lead to bimetallic corrosion.

iii. For brick masonry backing the sleeves of the expansion bolts shall be fixed in wedge shaped pockets having an area of 75mm x 75mm at the surface and 100mm x 100mm at the inner surface and shall be 125mm deep. The wedge could also be as a truncated cone of 75mm dia / 100mm dia. The dimensions shall be reviewed by the Engineer during execution of the work. The wedge shall be filled with PCC 1:1:2 (1 Cement, 1 Sand and 2 Coarse Aggregate) mixed with non-Shrink Compound in the proportion as recommended by the manufacturer.

iv. The holes drilled for the expansion fasteners shall be cleaned of all ground material, dust, etc. before inserting the expansion sleeves.

v. All expansion bolts fixed into soffits shall be bonded to the backing with epoxy/ polyester resin of approved make.

vi. All expansion bolt fixings shall be tightened in accordance with the recommended torque figures by the manufacturer. Where such values are not available the Contractor shall test at least 6 samples to determine the safe torque values. All bolts shall be tightened using torque spanner/ wrenches. All bolts shall be checked 24 hours (minimum) after installation and retightened if necessary.

No walls, terraces shall be cut for making any opening after water proofing has been done without written approval of the Engineer. Cutting of waterproofing when authorized by the Engineer in writing shall be done very carefully so that no other portion of the waterproofing is damaged. On completion of the work at such places, the water proofing membrane shall be made good and ensured that the opening / cutting is made fully waterproof as per specifications and details of water proofing approved by the Engineer at no extra cost. No structural member shall be cut or chased without the written permission of the Engineer.

Provision of grooves in plaster, drip courses etc. if directed, at junction of walls-ceilings, columns, walls, frames-plaster and such other generally typical locations shall not be paid extra, including grooves in concrete, masonry, stonework.

1.16 SAMPLING & MOCK-UPS

Major items of work for which samples and mock-ups shall be produced by the Contractor free of cost for approval by the Engineer-in-charge.

PARTICULARS OF ITEM	DETAILS OF SAMPLE
All Marble, Kota stone and granite stone, sandstone and all other stone flooring, copings	3 nos. of (1200 x 600) mm or actual size sample as per design and mock-up of each type showing edge rounding, polishing, flamed textures, etc.
Mirror, Glass	(150 x 150) mm size sample
UPVC doors/windows	Complete assembly including gaskets / accessories / sealants / lock etc.
Hardware	Complete set of each type
Wall claddings stones	3 nos. of samples, (2000 x 2000) mm size of each type of finish including cramps, etc.
Paints	All types in various shades and sizes, as directed (1000 x 1000) mm.
Stone flooring	1000 mm x 1000 mm approx. laid sample
Waterproofing treatment	Specialized agency and waterproofing system to be approved by Engineer-In-charge
False floor	Sample and mock-up of each system
Tactile on floors	Samples and mock-ups as per the requirement of the Engineer In-charge
Aluminium panel cladding	Mock-up Sample of panels 1000 mm x 1000 mm approx. laid sample
False ceiling (All types)	Panel of size (2000 x 2000) mm of each finish
All types of railings	Mock-up 2000 mm long also showing all bends and turning conditions
All types of paving	Samples and mock-ups as per the requirement of the Engineer In-charge.
All types of kerbs	Mock-ups as per the requirement of the Engineer-In-charge
Copings	Mock-ups as per the requirement of the Engineer-In-Charge
Fire check doors	Complete set including frame and accessories
Metal doors	Complete set including frame and accessories
Rolling shutter	Sample of lath

External finish	Mock-up of (2000 x 2000) mm of each type
Compact laminate panels	Sample of panels
GRC Screen	Mock-up Sample of panels 1000 mm x 1000 mm approx.
GRC panel, band, gutter	Mock-up Sample of panels 1000 mm in length
Galvalume metal panels	Mock-up Sample of panels 1000 mm x 1000 mm approx.
Translucent Film	Mock-ups as per the requirement of the Engineer-In-Charge
Structural Glazing work	Mock-up Sample of panels 1000 mm x 1000 mm approx.
Structural steel work	Mock-up of each element
Any other finishing item	Mock-ups as per the requirement of the Engineer In-charge

TECHNICAL SPECIFICATIONS

PART-I (CIVIL/INTERIOR)

SPECIFICATION OF MATERIALS & WORKS

GENERAL :

These particular specifications shall be read in conjunction with the General and Special conditions of the contract; Preambles to works; the C.P.W.D. Specifications of Central Public Works Department, New Delhi; the C.P.W.D. specifications for Electrical Works, the latest Bureau of Indian Standard Specifications Codes and the drawings. All the above quoted documents shall be considered supplementary to each other, however, in the case of conflict amongst the various provisions, the following order of precedence shall be adopted.

(a) In the case of conflict amongst the provisions of specification :

(i) Provision in the particular Technical Specification.
(ii) Provision in the State P.W.D. latest specifications.
(iii) Provision in the latest C.P.W.D. specifications/electrical specification.
(iv) Provision in the Indian Standard Specifications Codes.

b) In the case of conflict amongst the various drawings, the decision of the Architect shall be final and binding. If specifications for any item of work are not covered by any of the documents mentioned in para (a), the same shall be decided and conveyed by the Architect to the contractor and shall be binding upon him/them.

NOTE : CONTRACTOR WILL PROVIDE AT SITE OF WORK A COPY OF ALL THE SPECIFICATIONS REQUIRED TO COMPLETE THE PROJECT.

SECTION 5-1: CIVIL WORKS

1.0 Applicable Codes

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest editions including all applicable official amendments and revisions shall be referred to.

IS 3764:1992 reaffirm date Mar 2002	-	Code of safety for excavation work (first revision
IS 783:1985 reaffirm date Oct 2001	-	Code of practice for laying of concrete pipes (first revision)
IS 2320(Part 1):1983 Reaffirm date Dec 2002	-	Methods of test for soils: part 1 Preparation of dry soil samples for various tests (second revision)
IS 2720(Part 2):1973 Reaffirm date Dec 2002	-	Methods of tests for solids: Part 2 Determination of water content (second revision)
IS 2720(Part 3/Sec 2): 1980 reaffirm date Feb 2002	-	Methods of test for soils: Part 3 Determination of specific gravity Section 2 fine, medium and coarse grained soils (first revision)
IS 2720(Part 4):1985		Methods of test for soils: Part 4 Grain size

reaffirm date Dec 2002	-	analysis (second revision)
IS 2720(Part 5):1985 reaffirm date Dec 2002	-	Methods of test for soils: Part 5 Determination of liquid and plastic limit (second revision)
IS 2720(Part 22):1972 reaffirm date Dec 2002	-	Methods of test for soils: Part 22 Determination of organic matter (first revision)
IS 2720(Part 26):1987 reaffirm date Feb 2002	-	Methods of test for soils: Part 26 Determination of pH value (second revision)
IS 2720(Part 29):1975 reaffirm date Dec 2002	-	Methods of test for soils: Part 29 Determination of dry density of soils inplace, by the core-cutter method (first revision)
IS 6313(Part 1):1981 reaffirm date Sep 2005	-	Code of practice for anti-termite measures in buildings: Part 1 Constructional measures (First revision)
IS 6313(Part 2): 2001	-	Code of practice for anti-termite measures in buildings: Part 2 Pre-constructional chemical treatment measures (second revision)
IS 2720(Part 8):1976 reaffirm date Feb 2002	-	Methods of test for soils: Part 38 Compaction control test (hilf method)
IS 13415:1992 reaffirm date Mar 2002		Code of safety for protective barriers in and around buildings

Shop Drawings

For wet fixing and flooring work

This contractor shall submit shop drawings indicating all jointing locations and dimensions of stone slabs of all the stone work. Clearly indicate all methods of attachment and installation details to acceptable scales.

These drawings shall be submitted to Architect and Designer for review before any fabrication is commenced.

For dry fixing work

The contractor shall submit shop drawings prepared in AutoCAD and showing clearly the relationship to the external cladding works to the structure. They shall show the arrangement o components, they shall be submitted to the ENGINEER-IN-CHARGE & Architect for approval and shall include the following:

Preliminary Design Drawings for junctions of external cladding and concrete structure, other finishes fully describing the material, profiles, relevant sections, thickness, methods of installation and sealing., details of fixing methods and anchorage system to walls or structure, detailed joints, flashing details and all other pertinent information, including description of all finishes.

On approval of the preliminary drawing execution shop drawings shall be submitted and shall be based on the field measurement, having information as above and as listed below.

- Dimension and position of the stone panels for each stone clad elevation, scoffits, jambs, sills, and special features including highlighting the position of stone panels such as hand tooled panels, recessed stone panels, epoxy stone, slotted stone panels.
- Full size details including isometric drawings of sealing, flashing and jointing methods.
- Location and spacing of al types of stainless steel brackets, anchoring devices, accessories, etc.

Fully detailed programme for the submission of shop drawings to the ENGINEER-IN-CHARGE & Architect for approval and in no case shall the contractor proceed with any portion of the works without approved shop drawings.

All shop drawings shall be submitted in a sequence consistent with sequence of erection, installation or assembly of the various elements of the work. Proposed schedule of shop drawing submission shall incorporate adequate time for architect's review as well as possible revised submission and shall not be the cause of undue delay in scheduled projected completion. The contractor shall be deemed to have determined and verified all materials, site measurements and construction criteria related thereto and to have checked the shop drawings for complete dimensional accuracy.

Any approval by the ENGINEER-IN-CHARGE (based on the approval of the Architect and structural consultant) of shop drawing shall not relieve the contractor of his responsibility for any deviation from the requirements of the contract, including the project schedule, unless he has specifically informed the ENGINEER-IN-CHARGE in writing of such deviation at the time of submission and ENGINEER-IN-CHARGE and Architect has given written approval (backed by the approval of the Employer) to the specific deviations.

The contractor shall be required to submit 3 sets of prints of all shop drawings, as well as one soft copy.

The contractor shall only with the prior written approval of the ENGINEER-IN-CHARGE (backed by the Architect approval) modify material, fabrication, methods of erection and workmanship as may be necessary, if any of the test conducted in the Mock up have failed. The actual materials, fabrication, ejection and workmanship in the field shall match the approved test assemblies modified.

The work shall be executed as per the approved submittals only. Any deviation from the same shall be rejected. For unavoidable changes during the execution prior approval oaf the ENGINEER-IN-CHARGE & Architect shall be obtained prior to execution. The ENGINEER-IN-CHARGE & Architect shall approve all stone slab received at site before cutting and finishing.

Stone – Granite, Marble & Kota

Stone shall be reasonably uniform in colour, hard, sound, dense and homogeneous in texture, pattern, shape in accordance to the sample & of the required size and thickness approved by the ENGINEER-IN-CHARGE and Architect. The slab shall be selected so as to achieve a 'grain flow" when laid. Shade / tone, veining or pattern variation of more than 10% for stone selected and approved by Architect / Designer, shall be rejected and replaced at no cost to the Clients. Before placing order a sample of the flooring / cladding of minimum size 3m X 3m shall be installed at the site and got approved.

Finishes

All slabs shall have flamed or honed finish or as specified and cut to precise sizes as required. The slabs in external and internal wall veneer work shall be flamed or honed finish or as specified. The counter tops shall be of polished in the factory with silicon carbide abrasive stone starting from No '00' uto No.5, the final tin oxide polish shall not be used. All edges and exposed faces of slabs shall be polished. All edges of slabs shall be cut to the required chamfers, splays, quirks, and rounded on finished surface, all as per detailed approved shop drawings. Thickness of slab shall be within 2 mm for slabs to floors and vanity tops, counters etc. and 1 mm for slabs to walls, from that specified or indicted on drawing. For "seen" ends of slabs the thickness must be accurate to close limits of 1 mm.

All stone slabs in any one room or space shall be of the same colour, veining, pattern and matching – taken from the same block of stone.

Finishes are defined as follows:

Flamed: Flamed Finish shall be produced by application of high-temperature flame to the surface, which burst the stone crystals when the stone is heated. The operation shall be carried out by the series of flaming torch, flaming by single flaming

torch shall not be permitted since large surface may have shadow lines caused by overlapping of the torch. This finish shall vary in texture and depth between different types of granite, as the finish is largely dependent upon the granite structure of the stone.

Flamed with brush finish: The finish is same as mentioned above except that after flaming the surface is brushed to remove the flakes generated after the flaming. The brushing shall be done generally to one stork only.

Hand tooled finish: Hand tooled finish shall be produced by dressing the surface of the stone by removing the top layer of the stone by rough tooling with a punch chisel and a mason's or club hammer at close intervals and to a depth of about more than 3 mm to form an uneven textured pattern.

Water Jet: After certain treatment finishes on stone, such as flaming, a high pressure jet wash can be used to assist in cleaning the stone and bringing back more color to the stone.

Curved granite panel cladding

All curved panels shall be carved to the specified thickness and of the shape and size mentioned on the drawings. The panels shall be designed to fit the varying shapes.

Epoxy stone panels

These panels shall be factory finish only prior to installation. The stones shall be finished stone to the required size, finished on all sides as directed and shall be fixed to the parent stone wit the epoxy adhesive.

Material

Granite

Granite stone slabs of approved colour, size, thickness and finish shall be used as the cladding stone. The stones slabs shall be free from any damages including chipping or damage to the faces, flaws and breaking of edges. All such slabs with defects shall be removed from the site immediately.

Unless otherwise specified the permissible variations in dimension, minimum thickness of the stone behind the cramps mortise shall be as specified below.

Thickness of stone	**Allowable variation**	Stone behind cramp Mortise / slot
30 mm	+ /- 1 mm in total thickness and +2 mm in width and height	12 mm
40 mm	+ 5 mm in total thickness and + 2 mm in width and height	25 mm

Supporting System

Brackets and related fixing material should be of stainless steel of grade SS 316.

Unless otherwise specified anchor fasteners / expanding bolts shall be of Stainless Steel. Minimum effective penetration requirement of the fasteners / expanding bolts shall be 90 mm in concrete.

All dissimilar metal surfaces shall not be used & shall be isolated to prevent galvanic action. Refer the table 2 given below to prevent galvanic action.

Metal	**1**	**2**	**3**	**4**	**5**	**6**
Galvanized steel	Yes	No	Yes	Yes	No	No
Stainless steel	No	Yes	No	Yes	CC	CC
Cast iron	Yes	No	Yes	No	No	No
Aluminium	Yes	No	No	Yes	No	No
Copper, Brass	No	CC	No	No	Yes	Yes
Phosphor Bronze	No	CC	No	No	Yes	Yes

CC= Controlled Conditions i.e. presence of moisture (electrolyte) is prevented.

All steel parts shall receive a protective treatment commensurable with their respective functions. The treatment shall be one or more of those described in the specification and as approved by the ENGINEER-IN-CHARGE and Architect.

Aluminium if used, the surface in contract with mortar, concrete fireproofing, plaster, masonry and absorptive materials shall be coated with an anti-galvanic moisture-barrier material.

Sealants

Unless otherwise mention the sealant shall be medium modules, one part, elastomeric, high performance, gun grade silicon sealant of non staining, non striking high weather resistance and high UV type. Minimum width of the sealant shall be 12 mm if not specified elsewhere.

Plasticizer used in the some sealant may cause staining on the stone, hence manufacturer to conform the suitability of the sealant for the stone. Manufacturer's guarantee shall be required for serviced life of the sealant should be minimum 20 years.

Back up materials for using a bond breaker and controlling the depth of the sealant shall be closed cell, UV resistant polyethylene foam joint filler rods of diameter equal to sealant width or joint width plus 25%. This material should be sufficiently dense to provide support during applications of the sealant. The backer rod shall be recessed to sufficient joint depth so that after application of the sealant, a continuous groove of 5mm depth from the stone surface is getting formed. The recessed sealant shall be applied such that it forms a curvature to avoid water stagnation in the recessed areas.

Wherever specified the stone joints shall be finished with the granite dust power. The joint shall be sealed with silicon sealant recessed by 10 mm , when the sealant is still tack the granite dust of he same stone type shall be applied on the sealant. The granite dust be completely dry at the application.

Basis of designing the supporting system arrangement

The design and installation shall be to the Indian standards. Supporting / fixing system should be designed considering the following.

1 Dead load of the stone.

2 Wind pressure and suction equal to the basic wind pressure appropriate to the degree of exposure and height above ground level of individuals unit, taking into account the higher wind forces at the corners. Refer IS 875.

3 The design for fixing should allow for three-way adjustment to ensure proper fit within pre cut mortise in the stone.

4 It is important that the cladding should not be subject to undesirable stress which might rise from the attachment to the structure being too rigid and due to dimensional changes owing to elastic deformation, thermal movement, differential settlement, drying shrinkage, moisture movement, creep etc. Allowance shall be made for articulation of the cladding system.

5 Support elements shall be subject to a combination of direct load, being sheer, and torsional stress. The safe working stress in the supporting systems such as metal clamps / brackets shall be as per IS 4101 (part 1).

6 Load of two units shall be considered for designing the support / fixing system for each unit.
7 The number type and position of the fixing shall depend upon the stone to be used, thickness and face area of the unit, nature of substrate (concrete, block work).

Installation

The contractor shall executed one portion of the work as directed by ENGINEER-IN-CHARGE & Architect and get it approved from them till their satisfaction.

The stone units shall be as per approved samples. The units shall be worked to size indicated on the drawings and within specified limits of deviations and including any special shaping before delivery at site. The mortise, sinkages or notches should be carefully formed to ensure alignment of adjacent stone units and uniform gap at the joint of adjacent stone units as per approved drawings. Care should be taken to prevent chipping or other damages to the unit during cutting, making mortise or notches and other finishing, transportation, storage, handling & fixing.

Each stone shall be clearly marked and numbered before fixing

Storage of the stone units shall be arranged in such a manner that delivery in accurate sequence for site fixing is possible.

Scaffolding, lifting arrangement, temporary supports etc. shall be as properly planned and provided as per fixing requirements as well as safety requirements.

Stone units shall be fixed in position, in perfect line and level by using stainless steel (316 grade) cramp/hook inset in the cramp mortise and fixing the cramp / hook to the RCC wall by using stainless steel fasteners / expanding bolt in drilled hole of required dia. and length. Uniform widths of the joints shall be maintained in between the adjacent stone units.

After installation of the stone units on the clamps, they shall be adjusted to plumb and level and after accurate leveling all the notches shall be grouted with araldite adhesive to achieve proper fixing.

Fixing of the stainless steel clamps / brackets shall be coordinated with the waterproofing work on the support wall and shall not be commence till the completion of the curing period of the waterproofing system. The anchor holes shall be treated as per the instruction of the waterproofing system manufacturer / specialists.

It is recommended that for accommodating dimensional changes in the structure due to loading etc. the fixing of the stone units should be started at least after completion of the entire framework and construction of the walls etc. The compression & movement joints should be design and provided, if required and the stones should be installed accordingly.

All joints shall be thoroughly cleaned and inspected. After cleaning with the solvent PE material shall be inserted in the joints and the same shall be sufficiently fixed against the gap between the stone units to ensure supporting during filling of the sealant and controlling the depth of the sealant. Bond breaking tape shall be applied against the part of the cramp / hook inside the joint. Masking in both the sides of the joints shall be done with non-migrating adhesive tape to prevent the sealant adhering to the external face of the stone unit. Thereafter the sealant shall be put in positions by using gun / injecting device. The sealant shall be finished flush with the stone surface. Any sealant material if found over the external surface of the stone, the same shall be cleaned.

All stone cladding work at the windows / curtain walls / parapet copings / door jambs shall be coordinated with the aluminum flashing work and the stones shall not be installed till the completion of the fleshing work. The installation shall not damage the flashing work; any damage shall be rectified prior to installation.

During the execution the work shall be protected by using suitable covering.

On completion of the building work the face of the stone units shall be cleaned of all dust, rust and other stains etc. It is recommended that the scaffolding should be struck a cleaning down proceeds to avoid back splashing from scaffold boards and rust stains from scaffolding tubes. Surface shall be wiped down with a clear cloth.

Adequate protection measures shall be taken to ensure that exposed surfaces of the stone shall be kept free of mortar at all times as elements in mortar may etch the polished surfaces of some stones.

Replacement of damaged stone panels

All damaged stone panels shall be replaced on priority with the new stone panels without any extra cost to the client. Any stone which has developed the cracks due to the unnoticed fissures, micro cracks shall be replaced and any such replacement of this stone requiring removal of the existing stone shall be carried out by the contract without any extra cost to the client.

Scaffolding

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Tests

Tests on Anchors

On-site strength tests should be carried out on a representative number of each types and size of drilled-in anchors. Such tests are necessary to verify the performance and workmanship of the anchors installed and should be carried out under the direction of the registered structural ENGINEER-IN-CHARGE or authorized person.

Each representative anchor should be tested by means of either **:-**
Pull-out test; or
Equivalent tightening torque test, to demonstrate that its pull-out capacity is not less than 1.5 times the recommended tensile load as specified by the anchor manufacturer. The tested anchor should be considered satisfactory if it does not show any signs of separation, plastic deformation or deleterious effect during the test/Tests.
The contractor shall submit Manufacturer's test certificate for stainless steel items to the ENGINEER-IN-CHARGE and if asked for, the contractor shall also arrange for reconfirmation of grade, strength of the material and the quality of welding (if any) from a outside laboratory.

Tests on Stone Cladding Panels

Stone cladding is a natural material. The mechanical properties, physical properties and chemical properties can vary considerably between different types and grades of stones. Tests on stone cladding panels are required to be carried out to verify the characteristic strength adopted in the design and to form any part of quality assurance during construction. The characteristic strengths shall be not less than three times that of the designed strength used.

When stone cladding is to be used, the following tests are required to be carried out for each type of stone:

Compressive strength as per IS 11212 (part 1)
Transverse strength as per IS 1121 (part 2)
Sheer strength as per IS 1121 (part 4)
Water absorption & porosity IS 1124
Specific gravity as per IS 1122

Test on stone cladding assembly

On completion of the total assembly the system. The contractor shall submit for the consideration and approval of the ENGINEER-IN-CHARGE & Architect detailed descriptions of a testing programme, which shall include the following :

- Water penetration test

Test shall be carried out at a qualified independent test facility proposed by the Contractor and approved by the ENGINEER-IN-CHARGE All tests shall be carried out in accordance with the standards or other equivalent and approved standards.

In the even that such testing should result in uncontrolled leakage, the Contractor shall eliminate the causes of such leakage at no additional cost to the Employer, and repair or replace all damaged adjacent materials or assemblies as required. Remedial

measures proposed by the Contractor to maintain standards of quality and durability are subject to approval. The Contractor to provide powered scaffold, hose and sufficient personnel to operate scaffold and hose.

Sampling

In any consignment all the blocks / slabs of the same quarry shall be grouped together to constitute a lot. Samples shall be selected and tested separately for each lot for the tests specified.

Table 3 Samples size and criteria for conformity

Number of Blocks / slabs in the lot	Number of blocks / slabs to be selected in the sample	Permissible number or defectives	Sub sample size in number
(1)	(2)	(3)	(4)
Upto 100	5	0	3
101 to 300	8	0	3
304 to 500	13	0	6
501 to 1000	20	1	6

The samples selected under column 2 shall be tested for dimensional requirements and shall confirm to column 3. The lot not fulfilling the column 3 criteria shall be considered as defective.

The lot fulfilling the above criteria shall be tested for the strength related tests mention in the specifications and the number of test samples shall be as per column 4,

The test should be carried out by or under the direction and supervision of testing agency independent of the supplier of the stone cladding. The test results should be certified by the testing agency, and endorsed by the authorized persons or registered structural Consultant to confirm that the test results have reach the minimum recruitments as per IS 1123 & maximum requirement for water absorption as per IS 1124 and / or required characteristic strengths adopted in the design. No consent for the commencement of the stone cladding works shall be given until the test reports specified above for each type and grade of stone, selected randomly either from the first batch of stone delivered to site or from the block of stone sat the quarry that are to be used on the proposed project, have been submitted and found to be satisfactory b the ENGINEER-IN-CHARGE.

The method of sampling motioned above is for the stone block / slabs receive d at site in unfinished conditions, if the stone received at site is finished & made to size quality, the sampling criteria shall be as per the discretion of the ENGINEER-IN-CHARGE and shall be adequate to ensure the quality of the stone.

SS 304 TOP PIVOT FITTINGS

Material
Approved brand and manufacturer SS 304 grade top pivot fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 TOP & BOTTOM PATCH

Material
Approved brand and manufacturer SS 304 grade Top & Bottom Patch fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 D TYPE 300MM PULL HANDLE WITH 32MM DIA

Material
Approved brand and manufacturer SS 304 grade D type 300mm Pull Handle with 32mm dia fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.
Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 GLASS TO GLASS LOCK ROUND TYPE

Material
Approved brand and manufacturer SS 304 grade Glass to Glass Lock Round type fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 FLOOR SPRING (WEIGHT APPROX 100-120KGS)

Material
Approved brand and manufacturer SS 304 grade Floor spring (weight approx 100-120kgs) fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 LEVER HANDLE D-TYPE

Approved brand and manufacturer SS 304 grade Lever Handle D-type fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 MORTICE LOCK WITH KEY CYLINDER

Approved brand and manufacturer SS 304 grade Mortice lock with key cylinder fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 TOWER BOLT 250MM LONG WITH 10MM DIA

Approved brand and manufacturer SS 304 grade Tower bolt 250mm long with 10mm dia fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 TOWER BOLT 150MM LONG WITH 10MM DIA

Approved brand and manufacturer SS 304 grade Tower bolt 150mm long with 10mm dia fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 WALL MOUNTED DOOR BUFFER

Approved brand and manufacturer SS 304 grade wall mounted door buffer fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SS 304 DOOR STOPPER - DOOR MOUNTED HANGING TYPE

Approved brand and manufacturer SS 304 grade Door Stopper - door mounted hanging type fixed with SS screws etc. complete in all respects as per manufacturers' specifications & as directed by Engineer-in-charge.

Measurement
Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

TOILET CUBICLE

Toilet Cubicle (of following standard dimension which includes 600 mm door size width) made of heat, bacteria, water, chemical, scratch, impact and anti bacterial resistant 12 mm thick solid compact laminate panels Finish of the compact laminate should be raw silk which include doors, pilasters and intermediate panels finished with approved texture/shade as per the detail drawing and as per IS 2046 (Indian Standard) and as per fire retardant BS-476/97 standard.
This also includes providing and fixing in position necessary hardware made out of Stainless Steel (Grade 304) as per manufacturer's specifications and EIC instructions like (1) Door Knob, (2) Gravity Hinges, (3) Thumb turn lockset indicators, (4) Coat hooks, (5) U- Channels, (6) SS-Shoe Box Plate, (7) MS-Base Plate, (8) Rubber noise deafening tape, (9) Screws and wall Plugs.

All screws will be of 304 Grade in stainless steel with satin finish. All pilasters are supported by series stainless steel shoe box with MS- Base Plate. The Base of stainless steel shoe box will be anchored to the floor with a clearance height upto 110 mm. Fixing of intermediate panels to the wall shall be stainless steel 'L'- Bracket or stainless U- Channel section are fixed into wall with screw inserts.
All screws will be of 304 Grade in Stainless steel with satin finish. All pilasters are supported by stainless steel Bottom Cladding. The base of the stainless steel bottom cladding will be anchored to the floor with a clearance height upto 110 mm.

All intermidiate panels shall be 12 mm thick, pilasters and door shall be 18 mm thick with edges chamfered complete as per drawing and directions of Engineer- In- Charge.

Toilet Cubicle with standard dimension of 1840 mm Height x 1000 mm width x 1550 mm Depth, which include 600 mm door size width).
Toilet Cubicle I- Shape (Front Partion) with standard dimension of 1840 mm Height x 1000 mm width which includes 600 mm door size width).

Measurements
The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

Rate

Rate includes the cost of materials and labour involved in all the operations described above

ACOUSTICAL DOOR
Fixing of Noise Reduction doors (make ENVIROTECH or Equivalent) consisting of Door frame made out of good quality hard wood , section size – 100 mm x 110 mm fitted with ‘D’ type rubber gasket to block noise leakage from gap and acoustic door shutter with minimum 60 mm thickness along with fire rating and smoke Intumescent seal strip of size 10mm x 4mm for 120 minutes fire rated and STC 37dB Tested by reputedl Laboratory and having infill of 50mm thick resin bonded glasswool of 48 kg/cum density sandwiched by two 10mm thick approved quality marine grade ply and finished with 1 mm thick laminate of approved make, shade and colour and design on both sides. Further edges of shutter shall be provided with 6mm thick teak wood beading using exterior quality synthetic adhesive, headless GI nails, screws, beading finished with approved melamine polish etc. The ply shall be resistant to vermin, mould growth, minor impact, abrasion and short term water attack and with a smooth surface suitable to receive most forms of decoration. The door shall have acoustic seal in door rebates and drop dead seal at the bottom of the door including ironmongeries.HARDWARE :-The door assembly shall be fixed to the door frame with heavy duty hardware i.e. Geze/ Assa abloy/Dorma Make or equivalent make SS Hinge Size: 4”x 3”x 3mm , 600 mm SS door handle , SS Tower bolt ,Door closer , Panic Bar ,Panic trim etc.
ACOUSTIC INSULATION: The Panels filled with Acoustic material Rock wool confirming to IS-8183 of 96 kg/m3 density, very good noise absorber for high, mid & low frequencies along with, 6 MM thick anti donning layer having Thermal Conductivity 0.037 @ 20 C as per EN ISO 8497 (DIN 52613) and 2 mm thick Sound Damping layer MTS 05-303 to achieve higher Sound STC as per site condition.

Measurements
The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

Rate

Rate includes the cost of materials and labour involved in all the operations described above

6MM THICK LACQUER GLASS

Fixing of 6mm thick lacquer glass SGG Planilaque glass of approved color by architect/ Client with SGG Planifix silicon on perfectly leveled water proof non-conventional plywood (preferably marine plywood) of minimum 12mm thickness mounted on the RCC wall/any other structure. The SGG Planilaque lacquered glass to be of 6mm thick highly durable, humid resistance, poly urethane lacquer glass. The Planilaque glass should be manufactured by industrial curtain coating process. It should meet quality standards as per BS EN 1036 1999 & confirms to PERSOZ hardness test of at least 220 oscillations. The substrate of the glass should conform to Standard BS EN 572 1995 parts 1 and 2: Glass in Building – Basic soda lime silicate glass products. Planilaque lacquered glass to be manufactured to right specifications, relating to consistency of color, opacity and homogeneity throughout production campaigns and also to the ageing properties, mechanical resistance, and resistance to humidity and to chemical agents of the lacquer. The color of the lacquer should remain stable when exposed to normal levels of ultra-violet light in interior applications.

Measurements

The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

Rate

Rate includes the cost of materials and labour involved in all the operations described above

SS 316 GRADE GLASS RAILING IN SATIN FINISH

Installation of top/floor mounted SS 316 grade glass railing in satin finish made of SS top rail Φ 50x1.5mm thick mounted on SS round baluster of Φ 50x1.5mm thick with SS modular neck to hold the top rail, The total height of the installed rail including top rail will be 900mm from finish floor level. Further the baluster will infill with 13.52mm thick PVB Laminated (6mm clear tempered +1.52mm PVB+6mm clear Tempered) glass of height 650mm & length as per layout connected to the baluster with 2nos. of CNC made modular glass holder, The baluster will be top mounted with SS 304 grade plate of Φ 100x6mm thick fixed on the floor with M8 GI stud anchor with SS nut cap. all complete as per the Architectural drawings and as directed by the Engineer-in-Charge.

Measurement

Shall be measured in numbers and no extra payments shall be made for fixing etc.

Rate

Rate includes the cost of materials and labour involved in all the operations described above

TORSION SPRING, ALUMINIUM, PERFORATED, POWDER COATED PLANK CEILING SYSTEM SIZE 600X1200MM:

Fixing of torsion spring Plank Ceiling System, comprising of Plank of 600mm wide and 1200mm long manufactured out of 0.9mm thick Aluminium Alloy 3105 perforated 2.5mm dia 5.5mm c/c. With 16% open area. The metal ceiling panels shall be downward accessible with aminimum of four (4) torsion springs per panel. The Plank will be manufactured on advanced CAD/CAM equipment that includes several leveling stages in the manufacturing process. Torsion Spring panel with two side legs die formed and two end legs die formed and punched to receive torsion springs (min two springs each end or side) for secure engagement into Tee Grid main runners which are factory punched to receive torsion springs. Planks will be square edged. The metal ceiling panels shall be downward accessible with a minimum of four (4) torsion springs per panel. The Plank shall be Polyester powder coated in white colour. Main Runners: 24mm deep, inverted "Tee" sections, 3m long, with factory punched flanges to receive torsion spring assembly. Main Tee on center spacing to match panel length. Cross Runners: 24 mm deep, inverted "Tee" sections designed to interlock in to web of main tee section on designated spacing. Cross tee length to match panel length. Cross tees are spaced spacing 1200mm on center maximum. Suspension System: As per manufacturer standard considering type of plenum and its height. Paint finish – The panels will be pretreated in latest nano technology process and electro statically powder coated with automatic Carona system and cured with gas catalytic technology. Acoustic Felt: Non-woven felt made of glass-reinforced fibre glued over the perforation for sound absorption. NRC- 0.7 Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc. Approved Makes : Hunter Douglas(Luxalon) - Lindner –SS Metals or Equivalent

Measurements
The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

SUSPENDED FEATURE PANEL CEILING

Material
The feature panel shall be made as per detailed drawing. It shall be 75mm deep comprising of 19mm Thick. Commercial Board layered with 4mm Thk. Italian Veneer ply including all edge moldings, melamine polish, suspension system etc. complete as per drawing and as approved by engineer-in-charge.

Measurement
Length and breadth shall be measured correct to a cm & area shall be calculated up to two decimal place.

Rate
Rate includes the cost of materials and labour involved in all the operations described above.

SEMI-CONCEALED WOOD TILE CEILING
Fixing Modern semi-concealed Wood Tile Ceiling consisting of wood veneer tiles mounted on a 24 mm slotted tee bar system. The tilesshould be 16mm thick FR treated MDF (BS Class I) or a 16mm standard MDF (FR BS Class III) core veneered with 0.6mm thick slip/book matched veneer on the visible side. A 0.6mm compensating veneer should be adhered to the reverse of the tile. SUSPENSION should Consists of pre-punched main tee sections installed in a grid by means of inserting cross tees designed to be used with the size of tile selected. Maximum distance of rapid hangers fixing points on the main tee is 1200 mm. Main tees and cross tees will be finished standard baked enamel finish in colour. An acoustic non-woven textile of thickness 0.2mm shall be glued on reverse tile side. (Make Hunter Douglas (Luxalon), Armstrong or Equivalent)

a) 300 x 1200 wooden tile Ceiling system etc. complete as per drawing & as directed by Engineer-in-charge.

Measurements
The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

Rate
Rate includes the cost of materials and labour involved in all the operations described above

U BAFFLE ALUMINIUM PANEL CEILING
Fixing U Baffle Aluminium panel ceiling (M/s Hunter Douglas or Equivalent) consisting of Wood finish panel size 30 mm width X 100mm deep using 0.6mm thick, panel length upto 4 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium alloy AA 3005 (Al. Mg) for higher strength and good roll forming characteristics. Panels shall be clipped to a baked enamelled Aluminium carrier of 30 mm wide x 47 mm high x 0.5 mm thick, Black Colour coated, one leg of the carriers with cut outs to hold the panels in a module of 150 mm. Panel carrier shall be suspended by means of threaded rod at a distance of 1.8 mtr c/c. Aluminium panels shall be chromatised for maximum bond between metal and paint enamelled twice under high temperature, Exposed side with a full primer and finish coat on a Continuous Paint Line. Ceiling area above U Baffle to be painted in black colour before fixing this system

Measurements
The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

Rate

Rate includes the cost of materials and labour involved in all the operations described above

TRAP DOOR IN THE FALSE CEILING

Material

Trap doors shall be provided in the false ceiling using 20mm thk commercial ply laminated with approved finish laminate with necessary CP teak frame work of size 2" x 1.5", Oak wood moldings as per Architect's drawing, brass hinges, latches etc. complete to the approval of Engineer-in-Charge

Measurement

Length and breadth shall b measured correct to a cm & area shall be calculated correct to two decimal place.

Rate

Rate includes the cost of materials and labour involved in all the operations described above.

WOODEN WALL PANELING:

Material

Material shall be as specified in the schedule of items and approved by the Enginner-in-Charge.

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions rebates, rounding, and moldings as shown in the drawings made, before assembly. Patching or plugging of, any kind shall not be permitted except as provided.

Paneling

Grounds shall be provided as specified in the schedule of items. These shall consist of wooden framework using 25x50mm first class kail /hard wood sections at a maximum spacing of 600mm in any one direction (including adding members as required, fixed to the walls with nails/cleats, with wooden blocks grouted in the wall or any other approved method),covered with12mm thick BWP ply.

An additional layer of 6 mm commercial ply to fixed in strips as to form an approved pattern, the entire exposed area layered with 4mm thick veneer on one side pasted and pressed with adhesive to give a uniform and smooth finish, 12mmx12mm thick. Teakwood moldings, melamine polish two or more coat over French spirit polishing, preparation of surface etc. complete.

All sub frame members / ply etc. shall be treated with anti-termite solution as per norms. No extra shall be paid for making of openings, door / window frames and for making provisions for electric conduits. The battens shall be painted with priming coat, of approved wood primer before fixing.

Measurements

Length and breadth shall be measured correct to a cm. Moldings, carvings and any other ornamental work shall be inclusive in the item and not paid separately. Where plugs are required to be fixed for the ornamental work, the cost for the same shall be deemed to be included in the rate of ornamental work and no separate payment shall be made for plugs.

Rates

The rates include the cost of material and labour involved in all the operations described above.

PLASTERING AT JUNCTION OF MASONRY/R.C.C.

CHICKEN WIRE MESH AT JUNCTION

All junction of Masonry wall with R.C. structure e.g. column, beam, etc, which are to be plastered, shall be reinforced by fixing strips of approved 22 SWG G.I Chicken wire mesh 250mm wide with an overlapping of 100 mm centrally over the

length of junction. G.I. Chicken wire mesh of required width shall also be fixed over chasing for conduits, pipes, etc. on masonry walls before plastering is commenced. The mesh shall be nailed rigidly to the masonry with G.I. nails of suitable type of approx. 400 mm centres. The finished mesh shall be straight, rigid and laid without sagging. The contractor shall take into account the cost of G.I. chicken wire mesh white coating for plastering work.

Double scaffolding to be used shall be as specified.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

Where plastering is to be done over junction of two different materials e.g. concrete and masonry, the junction shall be covered by a chicken mesh of 100 mm width with margins on either side and then the plaster shall be applied. Where only one of the materials is plastered over, the plaster at junction shall be stuck to obtain a groove as shown below:

Measurements

Measurement for plastering work shall be in sq.m. correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the area plastered after making necessary deduction for openings for doors, window, fan opening etc. The actual plaster work carried out on jambs/sills of windows, openings, etc shall be measured for payment.

Rates
The rates include the cost of material and labour involved in all the operations described above.

PRELAMINATED AND POST FORMED CHAIR RAIL
Fixing prelaminated and post formed Chair Rail 150X12MM mounted directly on wall with ss studs as per detail drawings including all accessories complete as per direction of Engineer-In-Charge.

Measurements
Length will be measured in running metres correct to a cm. The length shall be taken along the finished face. The quantity shall be calculated in metre-cm units.

Rates
The rates include the cost of material and labour involved in all the operations described above.

ALUMINIUM LOUVERS
Material
Sun Louvers. The panels shall be 350 MM wide, 56 MM high in desired length upto a maximum length of 3500 MM. the panels shall be made out of 1.8 MM thick aluminium extrusion in Anodized / PVDF/ Mill Finish. The panels shall be installed horizontally or vertically to the frame in a fixed angle by means of aluminium sliding U profile, & fixation disc & fin suspension made out of fiber allowing it to lock at fixed degree in increments of 5 degrees from 0 to 180 degree. The fixation disc is clicked into position by sliding the U-profile section over the fin suspension. The ends of the panels shall be covered by aluminium plates having thickness 1.5 MM the panels shall be installed in a module of 335 MM giving an overlap of 15 MM.

Measurement
Shall be measured in running metres and no extra payments shall be made for fixing etc.

Rate
Rate shall include all required labour, material, designing, drawing conveyance, testing at approved laboratory breakage, wastage, supervision, protection till handing over.

Glass and Glazing

General

This section shall cove specification for supply and installation of all glass as shown in the drawings except for curtain wall. Type, thickness and size of glass shall be as specified. Approved workman specialized in their trade and as per best trade practices shall do glazing work as per details.

Thickness and Quality

Unless otherwise specified all glass shall be of float glass of approved make as per IS: 1761 and shall be ree form blisters, stain, scratches and bubbles and flaws of every kind and shall be property cut to fit frames and mullions. Unless otherwise indicated no glass shall be less than 4 mm thick. Samples of all glass types and finishes to be provided for Architect' review.

To Stack Vertically

All glass shall be stored vertical position set on edge of strip of wood or felt. It shall not be stacked horizontally. To the greatest extend possible, all glazed façade elements to be factory –produced.

To order Extra Quantity

All glass damaged/broken during storing/handling/transportation/execution of work shall be made good by the contractor on completion of the work at no extra cost. The Contractor shall stock sufficient additional quantity to make this easily possible.

Manufacture's Instructions

Notwithstanding anything contained hereinbefore manufacturer's instructions regarding storing, handling, cutting, glazing, cleaning, etc. shall be strictly followed.

Measurements to be taken

Before cutting, measurement of all glass required t suit site condition for fixing shall be taken at site. Glass shall be ordered slightly oversize for non tempered glass and cut at the site to fit properly. To greatest extent possible, all glazed façade elements to be factory-produced.

Preparation

Before commencing glazing work the work to receive the glazing shall be thoroughly checked for completion and proper condition of line, level, size & surrounding conditions and declared to be suitable for glazing, fixtures and finish hardware shall be fixed after installation of glass.

Cleaning & Protection of Glass

All glass and glazing shall be suitably protected until the time of handing over. All broken or damaged glass shall be replaced. All glass shall be washed clean before handing over. No glazing shall be completed until all stains have been removed from the surface and all glass thoroughly washed with soap and water and polished with approved glass polisher to the satisfaction of the ENGINEER-IN-CHARGE and Architect.

TECHNICAL SPECIFICATIONS

PART-II (PLUMBING & FIRE FIGHTING)

SECTION-1 TECHNICAL SPECIFICATIONS FOR PLUMBING & FIRE SUPPRESSION WORKS

1.0 Special Conditions

1.1 Scope of work

1.1.1 The form of Contract shall be according to the "Conditions of Contract". The following clauses shall be considered as an extension and not in limitation of the obligation of the Contractor.

1.1.2 Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialised services as described hereinafter and as specified in the Bill of Quantities and/or shown on the plumbing drawings.

1.1.3 Without restricting to the generality of the foregoing, the sanitary installations shall include the following:-

1. Plumbing Works

- Sanitary Fixtures& C.P Brass Fittings
- Soil, Waste, Vent, Pipes & Fittings
- Water Supply & Garden Irrigation System
- Sewerage.
- Storm Water Drainage.
- Water Supply & drainage Pumps.
- Water Treatment Equipment's.
- Sewage Treatment Plant.

2. Fire Fighting Works

- Fire Hydrant System
- Fire Sprinkler System
- Fire Pump & Accessories
- Fire Extinguishers

1.4 Services rendered under this section shall be done without any extra charge.

2 Specifications

2.1 Work under this Contract shall be carried out strictly in accordance with specifications attached with the tender.

2.2 Items not covered under these specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per specifications of the latest Central Public Works Department with upto date amendments as applicable in the Contract.

2.3 Works not covered under Para 2.1 and 2.2 shall be carried out as per relevant Codes & Bureau of Indian Standards and in case of its absence as per British Standard Code of Practice.

3 Execution of work

3.1 The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work. No extra charge made in consequence of any misunderstanding, incorrect information on any of these points or on ground of insufficient description will be allowed.

3.2 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of architectural, HVAC, electrical, structural and other specialised services drawings.

3.3 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule. All supports to the civil structure shall be provided with dash fasteners as per approved make only.

3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT chart or BAR chart for approval of the Project Manager/Architect/ Consultant. All dates and time schedule agreed upon shall be strictly adhered to within the stipulated time of completion/ commissioning along with the specified phasing, if any.

4 Drawings

4.1 Contract drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the architectural and other services drawings.

4.2 Architectural drawings shall take precedence over plumbing or other services drawings as to all dimensions.

4.3 Contractor shall verify all dimensions at site and bring to the notice of the Project Manager all discrepancies or deviations noticed. Decision of the Project Manager shall be final.

4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

4.5 Any drawings issued by the Architects/Consultant for the work are the property of the Architects/ Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

5 Inspection and testing of materials

5.1 Contractor shall be required, to produce manufacturers test certificate for the particular batch of materials supplied to him. Contractor may be required to get the material tested from outside approved laboratory for confirmation of material as per PM/Client instruction as and when required. The tests carried out shall be as per the relevant Bureau of Indian Standards.

5.2 For examination and testing of materials and works at the site Contractor shall provide all testing and gauging equipment necessary but not limited to the following:

a) Steel tapes
b) Weighing machine
c) Plumb bobs, sprit levels, hammer
d) Micrometres
e) Hydraulic

5.3 All such equipment shall be tested for calibration at approved laboratory, if required by the Project Manager. All testing equipment shall be preferably located in special room meant for the purpose.

5.4 Samples of all materials shall be got approved by Architect/ PM and Client and should be first make of the approved make list before placing order and the approved samples shall be deposited with the Project Manager.

6 Metric conversion

6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

7 Reference points

7.1 Contractor shall provide permanent bench marks, flag tops and other reference points and check that with other agencies to confirm the same reference point for all the proper execution of work and these shall be preserved till the end of the work.

7.2 All such reference points shall be in relation to the levels and locations, given in the architectural and plumbing drawings.

8 Reference drawings

8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the contractor in fulfilment of the conditions of this contract.

8.3. On award of the work the contractor shall be issued four sets of consultant's working drawings stamped "good for construction" by the Project Manager. The consultant's drawings shall be the basis of contractor's shop drawings. In addition, the Project Manager shall also be issue one copy of the Interior Designer's; Electrical & HVAC approved shop drawings relevant to his work for coordination purpose.

8.4 Shop drawings are detailed working drawings which incorporate the contractor's details for execution of the work and incorporate equipment manufacturer's details and dimensions to ensure that the same can be installed in the space provided.

8.5 All shop drawings should detailed pipe routing and levels, showing location of other services at crossings etc., cable runs, route cable trays and all allied works and must be fully co-ordinated with other services and approved by the Project Manager before execution of the works. Project Manager shall arrange to issue two copies/prints of services drawings from the respective contracting agencies. **All drawings will be valid only when stamped and issued by the Project Manager.**

8.6 Shop drawings shall also be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.

8.7 Six sets of manufacturer's equipment drawings, roughing in and wiring diagrams shall be submitted.

8.8 Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.

8.9 Three copies of each set of shop drawings shall be submitted for initial scrutiny, discussion and approval.

8.10 Each submission shall be accompanied by contractor's certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can be satisfactorily installed without any obstructions in the space available.

8.11 On approval of the above the contractor shall furnish six sets of the approved shop drawings for execution of the work.

9 Completion drawings

9.1 On completion of work, Contractor shall submit one complete set of original tracings and three prints of "as built" drawings to the PM duly approved and stamped by Consultant. These drawings shall have the following information.

a) Run of all piping, diameters on all floors, vertical stacks and location of external services.

b) Ground and invert levels of all drainage pipes together with location of all manholes and connections upto outfall.

c) Run of all water supply lines with diameters, locations of control valves, access panels.

d) Location of all mechanical equipment with layout and piping connections and mechanical equipment.

e) All shop drawings shall be updated from time to time for the purpose of making Completion drawings.

No completion certificate shall be issued unless the above drawings are submitted.

9.2 Contractor shall provide four sets of catalogues, service manuals manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

9.3 All "warranty cards" given by the manufacturers shall be handed over to the Project Manager.

10. Contractor's rates

10.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, all taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

10.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.

10.3 All rates quoted must be for complete items inclusive of all such accessories, fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

10.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by the Project Manager. Contractor shall provide holes, sleeves, recesses in the concrete and masonry work as the work proceeds. All hot and cold water supply pipes crossing masonry walls and floors shall be provided with G.I. pipe sleeves. The annular space between the pipe and sleeve shall be filled up with fire proof sealant after testing. Contractor shall give the pipe sleeves to the civil contractor well in time so that the same can be fixed along with civil works. Any co-ordination gap shall be of Plumbing contractor’s responsibility.

10.5 The Contractor shall furnish the Project Manager with vouchers & test certificates, to prove that the materials are as per the specification and to indicate that the rates at which the materials are purchased are in order to work out the rate analysis of non-tendered items which he may be called upon to carryout.

11 Testing

11.1 Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

11.2 Tests shall be performed in presence of the Project Manager and test records for the tests shall be duly signed by Plumbing Consultant, Contractor and the Project Manager.

11.3 All materials and equipment found defective shall be replaced at contractor cost and whole work shall be tested to meet the requirements of the specifications.

11.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet municipal or other bye-laws in force.

11.5 Contractor shall provide all labour, equipment and materials for the performance of the tests at no extra cost.

12 Site clearance and cleanup

12.1 The Contractor shall, from time to time, clear away all debris and excess materials accumulated at the site. Failing of which attract penalties:

12.2 After the fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints, stains, stickers and other foreign matter or discolouration leaving the same in a ready to use condition. The equipment installed shall be protected by contractor till formal handing over takes place by Client.

12.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done by the Project Manager at the Contractor's risk and cost. Cost of the cleanup shall be deducted from the contractor's bills on pro-rata basis in proportion to his contract value.

13 Licence permits and authorities

13.1 Contractor must hold a valid plumbing or any other licence as required by the municipal authority or other competent authority under whose jurisdiction the work falls.

13.2 Contractor must keep constant liaison with the local development, municipal/statutory authority and obtain approval of all drainage, water supply, fire suppression and other works carried out by him.

13.3 Contractor shall obtain, from the municipal and other authorities 'C' & 'D' forms approval of drainage and water supply works during execution and the completion certificate with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. Employer shall re-imburse the fees paid to the authorities towards the connection charges a production of receipts for money paid.

13.4 Contractor shall get any materials tested from the appropriate authority if so required at no extra cost.

14 Recovery of cost for materials issued to Contractors free of cost

14.1 If any materials issued to the Contractor free of cost, are damaged or pilfered, when in his possession, the cost of the same shall be recovered from the Contractor on the basis of actual cost to owner. The cost shall include the cost paid, freight, transportation, excise duty, sales tax, octroi, import duty and other levies, plus 100% as penalty. The decision on the actual cost given by the Employer shall be final and binding on the Contractor.

14.2 Contractor has to keep full records of material issued by the owner with reference and challans etc. Contractor has to give account of all such materials to the Project Manager.

15 Cutting of Water Proofing Membrane:

No walls terraces shall be cut for making and opening after water proofing has been done without written approval. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Project Managers. Actual cost of any damage to finished work by contractor shall be recovered from Plumbing Contractor.

16 Cutting of structural members

No structural member shall be chased or cut without the written permission of the Project Manager. Any damage to the structure shall be on contractor's account.

17 Materials supplied by employer

The Contractor shall verify that all materials supplied by the employer conform to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Project Manager.

18 Materials

18.1 Contractor to procure material as per first make from approved make list only unless otherwise specified and expressly approved in writing by the Project Manager/Client.

18.2 If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Project Manager.

Section IISpecifications forSanitary Fixtures& C.P Brass Fittings

1 **Scope of work**

1.1 Work under this section shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings specified hereinafter and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:-

a) Sanitary fixtures
b) Chromium plated fittings
c) Porcelain or stainless steel sinks
d) Accessories e.g. towel rods, toilet paper holders, soap dish, towel rack, coat hooks etc.

1.3 Whether specifically mentioned or not all fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

1.4 All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

2 General requirements

2.1 Sanitary fixtures shall be of the best quality approved by the Architect / Consultant / PM / Client. Wherever particular makes are mentioned, the choice of selection shall remain with the Architect / Consultant / PM / Client.

2.2 All fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specifications, drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, screws and required connection pieces.

2.3 Fixing screws shall be half round head chromium plated brass screws with C.P. washers where necessary.

2.4 Contractor shall furnish without cost all such accessories and fixing devices that are necessary and required but not supplied along with the Plumbing Fixtures & CP Fittings by the manufacturers as a part of the original and standard supply.

2.5 All fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractor's cost.

2.6 Contractor seal all fixtures fixed near wall, marble and edges. With an approved type of poly-sulphide sealant appropriate for its application.

3 European W.C

3.1 European W.C. shall be wash down or symphonic type wall mounted set flushed by means of dual flush Cistern systems which will be an integral part of the wall system. **Framework, walling and finishing will not form a part of the contractor's work.** Where applicable flush pipe / bend shall be connected to the W.C. by means of a suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

3.2 Each W.C. set shall be provided with a plastic seat shall be with rubber buffers and chromium plated hinges.

3.3 Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C. Each W.C. shall be suitable for flushing in low volume of water 5-6 litres.

3.4 Flushing Cistern shall be provided with all internal flushing mechanism, 15 mm dia ball cock with unbreakable polythene float and overflow pipe. Any frame work required for fixing cistern has to be provided by the contractor.

3.5 Lavatory basin

3.5.1 Lavatory basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.

3.5.2 Each basin shall be provided with brackets and clips of approved and securely fixed. Placing of basins over the brackets without secure fixing shall not be accepted.

3.5.3 Each basin shall be provided with 32 mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain as specified in the Bill of Quantities, 32 mm dia C.P. brass bottle trap with C.P pipe to wall and flange.

3.5.4 Each basin shall be provided with Mixer as specified in the Bill of Quantities.

3.5.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cms or as directed by Project Manager.

3.6 Sinks

3.6.1 Sinks shall be white glazed fireclay or vitreous china or stainless steel or any other material as specified in the Bill of Quantities.

3.6.2 Each sink shall be provided with brackets of approved and securely fixed. Counter top sinks shall be fixed with suitable brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40 mm dia C.P. waste with chain and plug as given in the Bill of Quantities. Fixing shall be done as directed by Project Manager.

3.6.3 Supply fittings for sinks shall be mixing fittings or C.P. taps as specified in the Bill of Quantities.

3.7 Toilets for Disabled

3.7.1 Where specified in washroom facilities designed to accommodate physically handicapped, accessories should be provided as directed by the Project Manager.

3.7.2 Stainless steel grab bars of required size suitable for concealed or exposed mounting and non-slip gripping surface shall be provided in all washrooms to be used by physically handicapped as directed by the Project Manager.

3.8 Shower set

3.8.1 Shower set shall comprise of single lever divertor, C.P. shower arm with wall flange, shower head and bath spout & hand shower of approved quality or as specified in the Bill of Quantities.

3.8.2 Shower mixer and shower arm shall be so fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

3.9 Urinals

3.9.1 Urinals shall be white glazed vitreous china of size, shape and type specified in the Bill of Quantities.

3.9.2 Bowl urinals shall be provided with 15 mm dia C.P. spreader, 40 mm dia stainless steel domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by C.I. brackets and C.I. wall clips as recommended by manufacturers complete as directed by Owner's Site Representative.

3.9.3 Urinals shall be fixed with C.P. brass screws and shall be provided with 32 mm dia domical waste leading to urinal's trap.

3.9.4 Flush pipes shall be G.I. pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Bill of Quantities.

3.9.5 Urinals shall be flushed by means of fully automatic no-touch flush valve with solenoid valves.

3.9.6 Waste pipes for urinals shall be G.I pipes (Medium class) to IS: 1239. Waste pipes may be exposed on wall or concealed in chase as directed by the Specifications for waste pipes shall be same as given in Section V.

3.10 Urinal partitions

3.10.1 Urinal partitions shall be white glazed vitreous china, marble, granite or any other material selected by the Owner's Site Representative. The same shall be fixed by Contractor executing the finishing work. The exact location shall however be co oriented by the Plumbing Contractor.

3.10.2 Urinal partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. Clips as recommended by the manufacturer and directed by Owner's Site Representative.

3.11 Accessories

3.11.1 Contractor shall install all chromium plated and porcelain accessories as shown on the drawings or directed by the Project Manager.

3.11.2 All C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Project Manager.

3.11.3 Recessed porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work as per Interior Designer's drawings.

3.12 Final Installation

The contractor shall install all sanitary fixtures and fittings in their position in accordance with approved trial assemblies and as shown on drawings. The installation shall be completed with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that the necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

3.13 Protection against Damage

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handling over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

3.14 Measurement

3.14.1 Sanitary fixtures and accessories shall be counted by numbers in the unit given in the Bill of Quantities.

3.14.2 Rates for all items shall be inclusive of cutting holes and chases and making good the same, C.P Brass screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

Section III Specifications for Soil, Waste, Vent & Rainwater Pipes & Fittings

1. Scope of work

1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all soil, waste, vent rain water pipes and fittings as required by the drawings, and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the soil, waste, vent pipes system shall include the following:-

a) Horizontal soil, waste and vent pipes, and fittings, joints, clamps, connections to fixtures.

b) Floor and urinal traps, cleanout plugs, inlet fittings.

c) Testing of all pipe lines.

2 General requirements

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 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.

2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps intervals specified.

2.5 Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawing so that other agencies are instructed to provide the same well in advance.

3 Piping System

3.1 Schedule of Pipes Use

1.	CI Spun Soil & Waste Pipes I.S 3989	Horizontal Soil, Waste. Vent With in toilets, up to Stacks.
2	GI pipes Heavy class 32, 40 & 50 mm dia.	Connections from fixtures to FT.
3	uPVC Rain water Pipes I.S 4985	For Rain water System.

3.2 Soil, Waste & Vent Pipes

a) The Soil & Waste Pipe System above ground has been planned as a "two pipe system" as defined in IS: 5329 having separate pipes for waste for kitchen sinks, bath tubs, showers, washbasins, condensate drains and floor drains and is approved by Project Manager.

b) Vertical soil & waste stacks shall be connected to a horizontal Soil and Waste Pipe as shown on the drawings.

c) Toilet layouts have been so arranged that the W.C. outlets shall be with "P" trap above ground.

3.3 Cast Iron Soil, Waste & Vent Pipes

a) All Soil, Waste & Vent Pipes used in building shall be Sand cast iron pipes as specified below.

b) All pipes shall be straight and smooth from inside free from irregular bore, blow holes, cracks and other manufacturing defects.

- Spun Cast Iron Pipes & Matching Fittings shall be to I.S. 3989

c) Standard weight, dimensions and pig lead required for joints shall be as follows:-

Cast Iron Soil Pipes & Matching fitting shall be to I.S. 3989

Nominal diameter	**thickness**	**overall Weight 1.83 m**	**internal diameter of socket**	**Depth of lead**	**Length**
Inches	**mm**	**mm**	**kg**	**mm**	**mm**		
2	50	5	11.41	76	25		
3	75	5	16.52	101		25	
4	100	5	21.67	129		25	
6	150	5	31.91	181			38

3.4 Tolerances

Acceptable tolerance for pipes to I.S 3989 shall be as follows:-

a) Wall thickness - 15%
b) Length ± 20 mm
c) Weight - 10%

3.5 Fittings

3.5.1 Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

3.5.2 Fittings shall be of the required degree of curvature with or without access door.

3.5.3 Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.

3.6 uPVC Rain Water Pipes

a) All Rain Water Pipes used in building shall be uPVC pipes as specified below.

b) All pipes shall be straight and smooth from inside free from irregular bore, blow holes, cracks and other manufacturing defects.

c) uPVC Pipes & Matching Fitting shall be to (IS 4985).

3.7 Fittings

3.7.1 Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

3.7.2 Fittings shall be of the required degree of curvature with or without access door.

3.7.3 Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.

3.8 Fixing

3.8.1 All vertical pipes shall be fixed by **Galvanised** clamps and galvanised angle brackets truly vertical. 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. Each stack shall be terminated at top with a cowl (terminal guard).

3.8.2 Horizontal pipes running along ceiling shall be fixed on galvanised structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

3.8.3 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.

3.9 Clamps

3.9.1 All pipe clamps, supports and hangers shall be galvanised. Factory made Pre fabricated clamps shall be preferred. Contactor may fabricate the clamps of special nature and galvanise them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanised.

3.9.2 Clamps shall be of approved designs and fabricated from M.S. flats (which shall be galvanised after fabrication) of thickness and sizes as per drawings or contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details/shop drawings to be submitted by the contractors.

3.9.3 When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanised expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

3.9.4 Structural clamps e.g. trapeze or cluster hangers shall be fabricated by electro-welding from M.S. Structural members e.g. rods, angles, channels flats as per Contractors shop drawing shall be galvanised after fabrication. All nuts, bolts and washers shall be galvanised.

3.9.5 Galvanised slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in Bill of Quantities. 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.

3.10 Traps

3.10.1 Floor traps

a) Floor traps where specified shall be siphon type full bore P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size).

b) Contractor shall provide all necessary shuttering and centring for the blocks. Size of the block shall be 30x30 cms of the required depth.

3.10.2 **Floor Trap inlet**

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type of floor or manhole inlet fitting fabricated from G.I. pipe without, with one, two or three inlet sockets welded on side to connect the waste pipe or joint between waste and inlet socket shall be lead caulked. Inlet shall be connected to a C.I. P or S trap. Floor trap inlet and the traps shall be set in cement concrete blocks where varied in floors as specified without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval ofProject Manager.

3.10.3 **Floor Trap Grating**

Floor and urinal traps shall be provided with 100 -150mm square or round Stainless Steel gratings as approved with frame and rim of approved design and shape or as specified in the Bill of Quantities approved by the Project Manager.

3.11 Jointing (CI Soil Pipes & Fittings)

Joints for Cast Iron Soil, waste vent, anti siphon age and rainwater pipes shall be made with drip seal.

3.12 Cleanout plugs

a) Floor Clean out Plug.

Clean out plug for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be lead caulked to the drain pipes.

3.13 Waste pipe from appliances

3.13.1 Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of GI pipes in typical Toilets kitchens, pantries, equipments and service areas where so required, and as given in the Bill of Quantities or shown on the drawings.

3.13.2 All pipes shall be fixed in gradient towards the connection to stack or drains. Pipes inside all toilets shall be in chase unless otherwise shown on drawings. Where so required and shown on drawings or directed by the Project Manager.

3.13.3 Galvanised pipes (Where specified or required at site for Waste only)
Pipes shall be galvanised steel tubes conforming to I.S.1239 (medium class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be painted with two coats of black bitumen paint and exposed pipes with one coat of red oxide primer and two or more coats of synthetic enamel paint or as given in the Bill of Quantities.

3.14 Cleanout on Drainage Pipes (CO Plugs)

a) Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Cleanout plugs shall be of size matching the full bore of the pipe but not exceeding 150 mm dia. CO Plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

b) Floor cleanout plugs shall be cast brass as given in Para 3.9 above.

c) Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanised sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.

3.15 Encasing in Cement Concrete

3.15.1 Encasing of pipes is required to provide stability to the line and prevent its damage during construction.

a) Cast iron soil and waste pipes under floor

Pipes laid in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 12 mm size) 75 mm in bed and all round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8 m.

3.16 Painting

3.16.1 Paints used shall be as specified in approved make list of approved quality and shade. Wherever directed pipes shall be painted in accordance with approved pipe colour code and direction of flow.

3.16.2 All cast iron, soil, waste, vent, anti-siphon age, rainwater pipe sand CI (LA) Drainage pipes in exposed locations e.g. in shafts, pipe spaces and service floors or fixed at ceiling levels shall be painted with two or more coats of synthetic enamel paint to give an even shade . CI Soil pipes buried under floors shall not be painted.

3.16.3 G.I. waste pipes buried in ground or fixed in chase shall be protected with 2 mm thick bitumen membrane tape with a final coat of hot or cold applied bitumen. Exposed waste pipes shall be painted with two or more coats of synthetic enamel paint.

3.17 Cutting and making good

3.17.1 Contractor shall provide all holes cut outs and chases in structural members necessary and required for the pipe work as building work proceeds. Wherever cut outs , holes are left in the original construction , they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

3.18. Sleeves/ Cut-outs.

3.18.1 Contractor shall utilised all cut out and sleeves provided during construction to prevent breaking. The annular space between the pipe and the sleeve shall be filled up with approved type of fire retardant sealant. When sleeves are misplaced or inaccurately located contractor shall make the holes in the wall or structural members at his own cost but only with the prior permission of the Project Manager.

3.19 Testing

3.19.1 Testing procedure specified below apply to all soil, waste and vent pipes above ground.

3.19.2 Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests.

3.19.3. All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

3.20 Measurements

3.20.1 General

a) Rates quoted for all items shall be inclusive of all work and items given in the Specifications and Bill of Quantities.
b) Rates are applicable for the work in basements, under ground, floors, in shafts at ceiling level area for all depths and building up to 45 m in height.

3.20.2 Rates are inclusive of cutting holes and chases in RCC and masonry work where no sleeves or cut outs have been provided during construction and making good the same.

3.20.3 Rates are inclusive of pre testing, on site testing, of the installations, materials and commissioning of the works.

3.20.4 Pipes (unit of measurement linear meter to the nearest centimetre).

3.20.5 C.I. soil, waste, vent, anti siphon age, rain water pipes, shall be measured net when fixed correct to a centimetre including all fittings along its finished length.

3.20.6 G.I. pipes shall measure per running metre correct to a centimetre for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples and nuts. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing

substance, quality, and finish. The diameters shall be nominal diameter of internal bore. No allowances shall be made for the portions of pipe length entering the sockets of the adjacent pipe or fittings.

All supports required to support the pipes from slab/ceiling/i/c dash fasteners, M.S. structural, slotted angles/channels including support bolts and nuts embedded in masonry walls and hangers etc shall be included in the item rate of pipe including the item of work given below:-

a) Expandable anchor fasteners
b) Galvanising of all supports and hangers
c) Cutting holes in walls, ceiling of floors and making good where permitted
d) Nuts, bolts and washers for fixing and assembling
e) Wooden/PVC pipe saddles for vertical or horizontal runs

3.20.7 Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports ,shuttering and centring cutting complete as described in the relevant specifications.

3.20.8 Fittings (excluding pipe fittings) (Unit of measurement by numbers)

Urinal traps, trap gratings, hoppers, cleanout plugs khurras shall be measured by number per piece and shall include all items described in the relevant Specifications and Bill of Quantities.

3.20.9 **Painting**

Painting of pipes and fittings shall be measured per running metre.

3.20.10 **Excavation for soil pipes**

No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for cast iron soil and waste pipes laid below ground, in sunken slabs or over basement rafts or for CI (LA) drainage pipes laid below ground.

Section IV Specification forWater Supply System

1. **Scope of work**

1.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

a) Distribution system from main supply to all fixtures and appliances for cold& hot water

b) Cold water supply lines from tube wells and city water connections to Under Ground Water Tanks.

c) Excavation and refilling of pipes trenches.

d) Insulation to hot water pipes

e) Control valves, masonry chambers and other appurtenances.

f) Pipe protection and painting.

2 General requirements

2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

2.4 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.

2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

2.6 Clamps, hangers and supports on RCC walls, columns & slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.

2.7. All pipe clamps, supports, nuts, bolts, washers shall be galvanised MS steel throughout the building. Painted MS clamps & MS nuts, bolts & washers shall not be accepted.

2.8 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3 Water Supply System

3.1.1 Contractor should study the site plan and water supply system diagram for an overview of the system.

3.1.2 It is proposed to provide dual flushing cistern for all WCs.

4.0 CPVC PIPES, FITTINGS

All cold water pipes inside the building up to 50mm diameter and where it specified shall be CPVC pipes.

4.1 MATERIAL

4.1.1 All pipes and fitting comply with ASTM D2446 standard.

4.1.2 CPVC fusion compound (solvent cement) as per ASTM F493.

4.1.3 All fitting are fusion bonding type (assembly using CPVC fusion compound) unless otherwise specified.

4.1.4 All metal transition are brass type with threads as per IS 554CPVC threaded fitting are not recommended.

4.2 INSTALLATIONS

4.2.1 Install product according to Ajay's installation instruction and manual and follow recommended safe works practices.

4.2.2 Keep pipe and fitting in original packaging until needed and store pipes in covered areas.

4.2.3 Use tools designed for use with plastic pipe and fitting.

4.2.4 Cut of minimum 25mm beyond the edge of the crack in case any crack is discovered in the pipe.

4.2.5 Cut the pipe as square (perpendicular) as possible before making joint. Always use sharp edge cutting tools. Sharpen holder tools periodically.

4.2.6 Always apply a heavy & even cost of CPVC solvent cement on pipe and a light cost inside fittings.

4.2.7 Use CPVC fusion compound confirming with ASTMF 493.

4.2.8 Always hold the fresh fusion compounded joint in place for 20-30 second.

4.2.9 Use brass threaded MTA's and FTA's for hot water & for transition to or from Metal.

4.2.10 Always conduct hydraulic pressure testing after installation to detect any leaks and faults. Wait for appropriate cure time before pressure testing. Fill lines slowly and bleed air from the system prior to pressure testing.

4.2.11 Deburr, bevel and clean mating surface of pipe and fittings before joining.

4.2.12 Rotate the pipe 80 degree to 190 degree to spread the CPVC solvent cement evenly in the while pushing the pipe into fitting.

4.2.13 Use Teflon tapes with threaded fitting.

4.2.14 Ensure that there no share edge in contact with the pipe while embedding the pipes on the wall or in the floors.

4.2.15 Provide vertical and horizontal supports as recommended using the plastic straps only.

4.2.16 Apply only water- based paint on exposed pipes and fitting.

4.2.17 Provide sleeves (pipe cover) at entry & exit it under slab installations & while crossing walls.Visually inspect all joints for proper cemented at the end of shift or day. A visual inspection of the complete system is also recommended during pressure testing.

4.1 G.I. Pipes & Fittings

4.1.1 Pipes shall be galvanised steel tubes conforming to I.S. 1239 of Medium / Heavy Class as specified in BOQ.

4.1.2 Fittings shall be malleable galvanised iron and shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include couplings, tees, reducers, nipples, unions, bushes. Fittings shall conform to I.S.1879-(Part I to X).

4.1.3 Pipes and fittings shall be jointed with screwed joints. Care shall be taken to remove burr from the end of the pipe after reaming with a proper time.

4.1.4 Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.

4.1.5 All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

4.2 Valves

All Valves shall be ball valve or butterfly valve as specified below or as per bill of quantities.

4.3 Pipe Supports

4.3.1 All pipes clamps, supports, hangers, rods, pipe supports, nuts bolts & washers shall be factory made galvanised or alternatively galvanised after fabrication to suit site requirements.

4.3.2 Stainless Steel Pipes in shafts and other locations shall be supported by galvanised clamps of design approved by Pipes in wall chases shall be anchored by G.I. hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. Structural. Pipes in typical shafts shall be supported on Galvanised slotted angles/channels as specified elsewhere.

4.4 Anchor Fasteners

4.4.1 All pipes supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

4.5 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and/or directed by Project Manager.

4.6 Flanges

Flanged connections shall be provided on pipes as required or where shown on the drawings, all equipment connections as necessary and required or as directed by Connections shall be made by the correct number and size of GI nuts, bolts & washers with 3 mm thick gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Bolt hole dia for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780. And C.I. butterfly valve to IS: 13095.

4.7 Trenches

All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

Dia of pipe	Width of trench	Depth of trench
15 mm to 50 mm	30 cms	75 cms
65 mm to 100 mm	45 cms	100 cms

4.8 Sand filling

CPVC / G.I Pipes in trenches shall be protected with fine sand 15 cms all round before filling in the trenches.

4.9 Painting

4.9.1 All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code given in these documents or specified by Consultant/Project Manager.

4.10 Pipe protection

4.10.1 All GI in wall chase and below floor in toilets (where so fixed) shall be protected against corrosion by the application of two coats of bitumen paint covered with polythene tape and a final coat of bitumen paint.

4.10.2 G.I. waste pipes buried in ground or sunken slab shall be protected with multi-layer bitumen membrane tape 3mm thick with a final coat of hot or cold applied bitumen. "Pypkote" or equivalent.

4.11 INSULATION

4.11.1 All hot water pipes shall be insulated with elastomeric closed shells circular pipes.

4.11.2 All insulation material shall be elastomeric closed shells foam has a high diffusion resistance factor that prevent excessive water diffusion that gives longer lifetime of material.

4.11.3 The insulation material having the property of resistance of fire i.e. in case of fire these materials do not drop and do not spread flames.

4.11.4 All insulation material as per din 1988/7 (standard for drinking water pipe installation and for avoiding corrosion damage and scale formation).

4.11.5 The thermal conductivity of material at 0 deg. C = 0.035 w/(m.K).

4.11.6 The temperature resistance of material between –45 deg. C to +116 deg. C.

4.11.7 The Thickness of insulation pipes as follows:

Size of pipes	Application of pipes	Location	Thickness of Material (mm)	Type of Section
15 mm to 40mm	Hot water supply	Concealed	6 mm	Tube Section
15 mm to 100 mm	Hot water supply	Exposed	13 mm	Tube Section

4.12 Valves

4.12.1 Ball Valves

Valves upto 40 mm dia. shall be screwed type Ball Valves with stainless steel balls, spindle, Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm^2, and accompanying couplings and steel handles.(to BS 5351)

4.13 Butterfly Valves

4.13.1 Valves 50 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

4.13.2 Butterfly valve shall be of best quality conforming to IS: 13095.

4.14Non Return Valve (Slim Type)

Where specified non return valve (dual type check valve) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality.

4.14.1 Each Butterfly and dual plate Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanised nuts, bolts and washers of correct length.

4.15 Testing

4.15.1 All pipes, fittings and valves after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 10 kg/cm^2 whichever is more.

Pressure shall be maintained for a period of at least two hours without any drop.

A test register shall be maintained and all entries shall be signed and dated by Contractor (s) and Project Manager.

4.15.2 In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the Contractor during the defects liability period without any cost.

4.15.3 After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

4.16 Measurement

All pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports. No allowance shall be made for the portions of pipe length entering the sockets of the adjacent pipe or fittings.

All supports required to support the pipes from slab/ceiling/i/c dash fasteners. GI. structural, slotted angles/channels including support bolts and nuts embedded in masonry walls and hangers etc shall be incl. in the item rate of pipe including the item of work given below:-

a) Expandable anchor fasteners
b) Galvanising of all supports and hangers
c) Cutting holes in walls, ceiling of floors and making good where permitted
d) Nuts, bolts and washers for fixing and assembling
e) Wooden/PVC pipe saddles for vertical or horizontal runs

Jointing with Teflon tape, white lead and insertion gasket of appropriate temperature grade.

Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.

Excavation, back filling, disposal of surplus earth and restoring the ground & floor in original condition.

4.17 Pipe Supports.

4.17.1 Rate quoted for supports & hangers shall be inclusive of:-

a) Expandable anchor fastens.
b) Galvanising of all supports & hangers.
c) Cutting holes in walls, ceilings on floors and making good where permitted.
d) Nuts, bolts and washers for fixing and assembling.
e) Wooden/PVC pipe saddles for vertical or horizontal runs.

4.18 Valves

Gunmetal, cast iron, butterfly and non-return valves and puddle flanges shall be measured by numbers and shall include wheels/caps, GI nuts, bolts, washers and insertion gasket.

4.19 Painting / pipe protection/insulation

Painting / pipe protection / insulation for pipes shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made. No extra payment shall be made for fittings, valves or flanges.

Section-V. Specification for Sewerage and Drainage system

a) Sewer lines including excavations, pipe lines, manholes, drop connections

b) Storm water drainage, excavation, pipe lines.

c) Drainage lines and open drains shall be laid to the required gradients and profiles.

d) All drainage work shall be done in accordance with the local municipal bye-laws.

e) Location of all manholes, etc. shall be got approved from the Project Manager. No drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager.

6.1 Excavation

6.1.1 Alignment and grade

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Project Manager.

6.1.2 Opening out trenches

In excavating the trenches, etc.The solid road metalling, pavement, kerbing, etc. And turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully sifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Project Manager.
The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Project Manager.

6.1.3 Obstruction of roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Project Manager.

6.1.4 6emoval of filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Contractor.

6.1.5 Excavation to be taken to proper depths

The trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating thereto and so that the inverts may be at the levels given in the sections.

6.1.6 Refilling

After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The back filling up to 75 cms above the crown of the sewer pipe shall consist of the finest selected materials

placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled

carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Project Manager.

6.1.7 Contractor to restore settlement and damages

The Contractor shall, at his own costs and Charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and Charges, repair and make good any damage done to buildings and other property. If in the opinion of the Project Manager.

6.1.8 Disposal of surplus soil

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

6.1.9 Width of trench

Recommended width of trenches at the bottom shall be as follows:-

100 mm dia pipe	55 cms
150 mm dia pipe	55 cms
225-250 mm dia pipe	60 cms
300 mm dia pipe	75 cms
400 mm dia pipe	80 cms
600 mm dia pipe	100 cms

6.2 HDPE Double Wall Corrugated Pipes for Sewerage System

6.2.1 HDPE pipes shall be double wall corrugated (DWC) conforming to IS: 16098 & Jointing pipes and fittings shall be rubber ring.

6.2.2 Laying and jointing of HDPE pipes

a) Pipes are liable to be damaged in transit and not withstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.

b) The pipes shall be laid with sockets leading uphill and rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

c) Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete at the Contractor's cost and Charges.

d) If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed to ensure even bearing.

6.3 Gully traps

a) Gully traps shall be of the same quality as described for stoneware pipes in clause 5.2 above and used where shown on drawings.

b) Gully traps shall be fixed in cement concrete 1:4:8 mix and a brick masonry chamber 30x30 cms inside in cement mortar 1:5 with 15x15 cms grating inside and 30x30 cms C.I sealed cover and frame weighing not less than 7.0 kg (approx.) to be constructed as per standard drawing.

6.4 Reinforced cement concrete pipes

6.4.1 All underground storm water drainage pipes and sewer lines where specified shall be centrifugally spun S & S RCC pipes of NP2 / NP3 class. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work.

6.4.2 Laying R.C.C. spun pipes shall be laid on cement concrete bed as specified and shown on the detailed drawings.

6.4.3 Jointing

After setting out the pipes the socket shall be centered over the spigot and filled with cement mortar 1:1 (1 cement: 1 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degrees to the longitudinal axis of the pipe.

6.5 Manholes and chambers

6.5.1 All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the Bill of Quantities.

6.5.2 All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Bill of Quantities or shown on the drawings.

6.5.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal Size) as per standard details.

6.5.4 All manholes shall be plastered with 12/15 mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster mixed with water proofing compound.

6.5.5 All manholes with depths greater than 1 m. shall be provided with plastic coated catch rings set in cement concrete vertically and staggered.

6.5.6 All manholes shall be provided with steel Fibre reinforced plastic (SFRC) covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the Bill of Quantities or given above.

6.6 Cement concrete and masonry works (for manholes etc.)

6.6.1 Materials

a) Water

Water used for all the constructional purposes shall be clear and free from oil, acid, alkali, organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for constructional purpose.

b) Aggregate for concrete

The aggregate for concrete shall be in accordance with I.S.383 and I.S. 515.in general; these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Architect/Construction Management Consultant/ Project Manager. The size of the coarse aggregate shall be done as per I.S.383.

c) Sand

Sand for various constructional purposes shall comply in all respects with I.S. 650 and I.S. 2116. It shall be clean, coarse hard and stone, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Architect/ Project Manager'

d) Cement

The cement used for all the constructional purposes shall be grade 43 or 53 conforming to I.S.269.

e) Mild steel reinforcement

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I.S. 432 Grade I.

f) Bricks

Brick shall have uniform Colour, thoroughly burnt but not over burnt, shall have plain rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Architect/ Project Manager

g) Other materials

Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Architect/ Project Manager

6.6.2 Cement concrete (plain or reinforced)

a) Cement concrete pipes bedding, cradles, foundations and R.C.C. slabs for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Architect/Construction Management Consultant/ Project Manager Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

b) Concrete work shall be of such thickness and mix as given in the Bill of Quantities.

c) All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during the curing period.

6.6.3 Masonry work

Masonry work for manholes, chambers, septic tanks, and such other works as required shall be constructed from1st class bricks or 2nd class as specified in the bill of quantities in cement mortar 1:5 mix (1cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

6.6.4 Cement concrete for pipe support

a) Wherever specified or shown on the drawings, all pipes shall be supported in bed all round or haunches. The thickness and mix of the concrete shall be given in the Bill of Quantities.

b) Unless otherwise directed by the Architect/Construction Management Consultant/ Project Manager cement concrete for bed, all around or in haunches shall be laid as follows :-

Depth	Upto 1.5 m Depth	Upto 3 m Depth	Beyond 3 m
Stoneware pipes In open ground (No sub soil Water)	all round (1:4:8)	in haunches (1:4:8)	all round (1:4:8)
R.C.C or SW In sub soil Water	All round (1:3:6)	in haunches (1:3:6)	in haunches (1:3:6)
C.I. Pipes (In all Conditions)	All round (1:3:6)	in haunches (1:3:6)	in haunches (1:3:6)
R.C.C. Pipes	All around (1:4:8)	all around (1:3:6)	all around (1:3:6)

(Ratio refer to cement: coarse sand: stone aggregate 40 mm nominal size)

Section – VI Specifications for Water Supply & Drainage Pumps

1. Scope of work

Work under this section shall consists of furnishing all labour, materials, equipment and appliances necessary and required to supply install and commission the water supply and drainage pumps as described hereinafter and given in the schedule of quantities and/or shown on the drawings.

2. General requirements

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager/Owner rep.

2.2. All equipment shall be of the best available as per approved make list manufactured by reputed firms.

2.3. All equipment shall be installed on suitable foundations true to level and in a neat workmanlike manner.

2.4. Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.

2.5. Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

2.6. Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side along with pressure gauges as required.

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2.7. All pump couplings and belt guards for air compressors shall be totally enclosed with 5 mm mesh.

Specifications for Pumps

3. Variable speed pumping system for water supply systems

3.1 Water supply pumping system for the building shall be fully automatic variable speed drive system, packaged skid mounted system with three vertical centrifugal pumping sets and arranged in a manner to operate the entire system between pre-determined operating conditions specified. Pumps shall be protected against running dry by providing low level electronic cut off switch separately for system selected. The system will be provided with an integral programmable sequence controller so that each pump operates sequentially and no single pump remains idle. The system will also be provided with stainless steel vessel of capacity as per manufacturer's recommendations with timing mechanism to ensure that each pump operates for a minimum period of one minute between two starts. Pumps shall have a pump head / efficiency curve to operate within the range given in the specifications. The pumps selected shall be suitable for continuous duty operating.

3.2 All systems offered will be complete packaged systems comprising of the pumps, stainless steel vessels, variable speed control systems, sensors, pressure gauges and switches.

3.3 Items of the work given are broad indications for progressive payment. Notwithstanding the descriptions, BOQ and drawings issued with the tender, offer for which system must be complete in all respects in ready to use condition. Contractor must include all items necessary and required, whether described in the specification, drawing and BOQ.

4 Pumping sets for Water Transfer Pumps (Imported Stainless Steel Pumps)

4.1 Water supply pumps shall be suitable for clean filtered water. Pumps shall be single/multi stage vertical, centrifugal pumps with stainless steel body and stainless steel (DIN W-Nr .1.4301) impeller, stainless steel shaft and mechanical seal and coupled to a TEFC electric motor. Each pump should be operating to a curve required by the operating conditions.

4.2 All parts in contract with water shall be corrosion resistant stainless steel DIN-Nr.1.4401.

4.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 410 volts, 3 phases, 50 cycles A.C. power supply and shall conform to IS 325 operating at 2900 RPM nominal speed.

4.4 Each pumping set shall be provided with 100-mm dia gunmetal "Borden" type pressure gauge with gunmetal valve and connecting piping.

4.5 Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Project Manager/Owner rep.

5. Submersible pumps

5.1 Submersible pumps for sewage/drainage shall be single stage, single entry pump. Pump shall be with C.I. casing and C.I. two vane open type dynamically balanced impeller connected to a common shaft to the motor. The vane for sewage pump will be open type, while for drainage pump etc. It will be of semi open type.

5.2 Stuffing box shall be provided with mechanical seals

5.3 Each pump shall be provided with water cooled squirrel cage induction motor suitable for 415 volts, 3 phase, 50 cycles AC power supply.

5.4 Each pump shall be provided with liquid level controller for operating the pump between predetermined levels. Operation of level controller shall be similar to as discussed in Para 6.1 & 6.2 below.

5.5 The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.

5.6 Pump shall be provided with all accessories and devices necessary and required for the pump to make a complete working system.

6. Level Controllers

6.1 Level controllers shall be electronic low voltage type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications: -

6.2 Filter feed pumpand domestic water transfer pump.

To start/cut off all operating pumps when:-

a) Water level is low in storage water tanks with low water level audible alarm.

b) To cut off filter feed pump and domestic water transfer pump when water in tank is full.

6.3.1 Sump Pump level controller & high water alarm

To cut off the drainage sump pump when the sump is empty and to start when:-

a) Duty pump No. 1 at pre-determined level No.1

b) Duty pump No. 2 at a higher pre-determined level.No.2

7. Pipe & Fittings (for Headers and Connections)

7.1 Pump suction and delivery headers shall be Galvanized iron pipes heavy class with matching fittings. The pipe joints shall be threaded as per manufacturer's instructions.

7.2 Vibration Eliminators

Provide on all suction and delivery lines as shown on the drawings double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer details.

7.3 Valves

7.3.1 Butterfly Valves

Butterfly Valves shall be cast iron body with following details:-

a) Disc shall be CI heavy duty electrolysis nickel plated abrasion resistant.

b) The shaft is EN-8 Carbon Steel with low friction nylon bearings.

c) The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.

d) Built in flanged rubber seals.

e) Actuator to level operated for valves above ground and T Key operated for valves below ground.

f) Built in flanges for screwed on flanged connections.

Manufacturer's details on fixing and installation will be followed.

7.3.2 Non Return Valves (NRV)

a) Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.

b) NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform BS.

8. Painting and cleanup

a) On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.

b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.

c) Provide painted identification legend and direction arrows on all equipment and piping as directed by engineer-in-charge.

d) On final completion of the work, contractor should cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

9. Measurement

9.1 General

9.2 Unit rate for individual items, e.g., Pumps, MCC and level controller are for purposes of payments only. Piping, headers, valves, accessories, cabling and MCC to measured separately in this contract only.

9.3 All items must include all accessories fittings as described in the specifications, BOQ and shown on the drawings.

9.4 All water supply pumps

Pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

9.5 Level controllers & Alarms

Level controllers for each set of pumps shall be measured by number and inclusive of probes, cabling unto surface box near the pump and shall include all items as given in the specifications and schedule of quantities to provide a complete working system.

9.6 Piping Work

9.6.1 Suction and delivery headers for each pumping system shall be measured per linear meter of finished length and shall include all items as given in the schedule of quantities. Painting shall be included in rate of headers.

9.6.2 G.I. pipes between various equipment's shall be measured per linear meter of the finished length and shall include all fittings, flanges, jointing, clamps for fixing to walls or hangers and testing. Flanges shall include 3 mm thick insertion rubber gasket, nuts, bolts and testing.

9.6.3 Water Tank, Vibration eliminators, "Y" strainers, butterfly valves, slim non return valves shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications.

Section VII: Specification for Water Treatment Equipment's

1. General requirements

1.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager/Owners rep.

1.2. All equipment shall be of the best available make manufactured by reputed firms.

1.3. All equipment shall be installed on suitable foundations, true to level and in a neat workmanlike manner.

1.4. Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.

1.5. Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

1.6. Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side

1.7. All pump couplings and belt guards for air compressors shall be totally enclosed with 5 mm mesh.

2.0 Corrosion Resistant Material

2.1 All piping, valves and accessories from outlet of raw water to inlet of treated water tank shall be of material fully resistant to internal and external corrosion. Such material may be stainless steel, PVC, rubber or other type of lining material accepted in international water works engineering practice.

3. Water filters for water supply

3.1 Filter shall be designed in accordance with the code of unfired pressure vessel conforming to I.S. 2825.

3.2 Water filter shall be pressure dual media filter may be altered to suite contractor's own design of the most efficient performance.

3.3 Filters shall be vertical type of required diameter. The shell and dished ends shall be fabricated from M.S. sheet tank suitable to with stand a working pressure given in Bill of quantities. The shell shall have a minimum thickness of 6 mm and dished ends 8 mm or as per manufactures recommendations.

3.4 Each filter shall have at least one pressure tight manhole cover for inspection and repairs.

3.5 Each filter shall be provided with screwed or flanged connections for inlet, outlet individual drain connections and all face piping, diaphragm valves and all other connections necessary and required.

3.6 Face piping shall be G.I. class 'C' as per IS: 1239.

4. Water Softener

4.1 Softeners shall be designed in accordance with the code of unfired pressure vessel conforming to I.S. 2825.

4.2 Softeners shall be designed to remove the hardness of water. Softener shall provide with suitable grade of Cation exchange resins in quantity to be indicated by the contractor at the time of tendering.

4.3 Softener vessel shall be fabricated from MS sheet with dished ends and self-supporting arrangement. Vessel shall be suitable for a working pressure given in bill of quantities. The shell shall have a minimum thickness of 6 mm and dished ends 8 mm.

4.4 The vessel shall have an internal collecting and distribution system of manufacturer's design.

4.5 Softener shall have a set of face piping for inlet, outlet brine injection with all valves. Suitable drain shall be provided. Pipes shall be GI class 'C'.

4.6 One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicating lamps.

4.7 One cylindrical FRP saturator and mixing tank, provided with brine delivery piping with adjustable level indicating clamp and control valves complete. The tank shall be of capacity as given in the bill of quantities.

4.8 One orifice board for indicating wash and rinse rate to be filtered in drain sump.

4.9 One charge of supporting gravel, sand and "Cation" resin in requisite quantity.

4.10 One water testing kit with instructions for testing water samples.

5. Chemical Dosing Pump

5.1 Chemical dosing system comprising of metering pump, 100 lts. Capacity HDPE solution tank with level gauge and lid on top.

5.2 Motor driven metering pump with mechanically activated diaphragm with oil lubricated gear mechanism. The output of the plug should be adjustable operation from 10-100 %. Pump construction shall be corrosion resistant polypropylene or similar material.

5.3 Each pump shall be provided with an injector assembly with suction and delivery piping complete in all respects.

6.0 R.O. PLANT

The water treatment equipment shall be based on the following Criteria:

6.1 Raw Water Parameters

S. No.	Parameters	Raw Water (Inlet) Properties of water	Unit	Desirable Limits Drinking Water as per IS 10500	Extended Limits Drinking Water as per IS 10500
1	Colour		hazen	5	
2	Odour		-	-	
3	Taste		-	-	
4	Turbidity		NTU	5	
5	PH Valve		-	6.5 - 8.5	
6	Total Hardness (as CaCo3)		mg/l	300	600
7	Iron (as Fe)		mg/l	0.3	
8	Chlorides (as Cl)		mg/l	250	1000
9	Fluoride (as F)		mg/l	1	
10	Total Dissolved Solids		mg/l	500	2000
11	Calcium (as Ca)		mg/l	75	

12	Magnesium (as Mg)		mg/l	30	100
13	Copper (as Cu)		mg/l	0.05	
14	Manganese (as Mn)		mg/l	0.1	
15	Sulphate (as SO4)		mg/l	200	400
16	Nitrate (as NO3)		mg/l	45	
17	Pheriolic Compounds		mg/l	0.001	
18	Mercury (as Hg)		mg/l	0.001	
19	Cadmium (as Cd)		mg/l	0.01	
20	Selenium (as Se)		mg/l	0.01	
21	Arsenic (as As)		mg/l	0.01	
22	Cyanide (as CN)		mg/l	0.05	
23	Lead (as Pb)		mg/l	0.05	
24	Zinc (as Zn)		mg/l	5	
25	Detergents		mg/l	0.2	
26	Chromium Total (as Cr)		mg/l	0.05	
27	Total Alkalinity		mg/l	200	
28	Aluminium (as Al)		mg/l	0.03	
29	Boron (as B)		mg/l	1	

6.2 Required Treated Water Parameters

S. No.	Parameter	Unit	Value
1	PH Value	-	7.2 – 7.5
2	Colour	hazen	Clear
3	Total Hardness	mg/l	< 50
4	Iron	mg/l	< 0.05
5	Chlorides	mg/l	< 50
6	Total Dissolved Solids	mg/l	< 100
7	Magnesium	mg/l	Nil
8	Sulphate	mg/l	< 100

6.3 Reverse Osmosis Plant

6.3.1 Reverse Osmosis plant shall consist of:

a) Sodium Hypo-chloride dosing system to reduce the organic matter present in the raw water

b) Chemical dosing system to neutralize residual free chlorine present in the filter water for complete de-chlorination.

c) Antiscalant dosing system to protect the membranes from fouling.

d) 5 micron cartridge filter is to be provided as per treatment to the R.O. system to protect R.O. membranes from chocking.

e) R.O. high pressure feed pump shall be vertical multistage stainless steel centrifugal pump connected to direct driven totally enclosed fan cooled cage induction motor of required H.P. The motor shall be suitable for 410 volts, 3 phase, 50 cycles, A.C power and shall confirm to IS: 325 operating at 2900 RPM nominal speed.

f) Reverse osmosis membranes of required quantity as per manufacturer's. The elements shall be hollow fiber or spiral wound having a high filtration rates. Elements must have a high operational life and sturdy.

g) The entire plant must be provided with all controls, sensing devices, conductivity meter, pressure gauges, valve and all other accessories necessary and required for a complete operational plant.

h) The entire plant shall be of approved corrosion resistant materials to be clearly specified in the bid.

6.4 Process of Treatment Plant

a) The raw water is pumped through Pressure Sand Filter to remove suspended and organic Impurities from the raw water

b) The Filtered is passed through cartridges filter as final filtration.

c) High Pressure booster pump shall be provided to boost the pressure of water from cartridge Filter. The water at designed pressure shall be entering into RO Module.

d) The Treated water from R.O. Module to be stored in treated water storage tank after dosed with pH enhancing chemicals (sodium carbonate) through pH dosing system to raise the pH To 7.4.

e) The rejected water from the R.O. Plant shall be sends to the normal drain and finally connected With deep rainwater harvesting pit (up to sea water level).

f) A chemical holding tank and necessary piping shall be installed to conduct onsite cleaning ofMembranes.

7. Pipe & Fittings (for Headers and Connections)

7.1 Pump suction and delivery headers shall be of approved corrosion resistant material with matching fittings. The pipe joints shall be threaded or as per manufacturer's instructions.

7.2 Vibration Eliminators

Provide on all suction and delivery lines as shown on the drawings double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer details.

7.3 Valves

Valves 50 mm dia and above shall be rubber lined butterfly valves.

Non return valves shall be rubber lines cast iron slim type of approved make.

8.Flow measurement

8.1 Provide Rota meter reading "LPH" or "LPM" on delivery line of the plant.

8.2. Provide one direct reading flanged type water meter with strainer on outlet of water softener or water filter.

9. Painting and cleanup

a) On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.

b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.

c) Provide painted identification legend and direction arrows on all equipment and piping as directed by Project Manager.

d) On final completion of the work, contractor shall cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

Section VIII Commissioning and Guarantees (Plumbing System)

1 Scope of work

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

2 General requirements:

2.1 The rates quoted in this tender shall be inclusive of the works given in this section.

2.2 Contractor shall provide al tools equipment, metering and testing devices required for the purpose.

2.3 On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

3 Pre-commissioning

3.1 On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices, the contractor shall proceed as follows:-

A water supply system:

i) Check all control valves and close if any valve is open. Also check all suction and delivery connections are properly made.

ii) Test run and check rotation of each motor and correct the same if required.

B Pipe work

i) Check all clamps, supports and hangers provided for the pipes.

ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

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B. Handing over

1) All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager, and the job handed over to the Project Manager, or his authorized representative.

2) Contractor shall also hand over, to the Project Manager, all maintenance & operation manuals and all other items as per the terms of the contract.

C. Guarantees

1) The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

2) The form of warranty shall be as approved by the Project Manager.

3) The warranty shall be valid for a period of one year from the date of commissioning and handing over.

4) The warranty shall expressly include replacement of all defective or under capacity equipment. Project Manager may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

5) The warranty shall include replacement of any equipment found to have capacity lesser that the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Project Manager.

Section IX: Electrical Installations

1 Scope

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric control panels, wiring and Earthing of all air conditioning equipment, components and accessories, including supply, installation and wiring of remote control-cum-indicating light panel.

2 General

Work shall be carried out in accordance with the Specifications, Local Rules, Indian Electricity Act 1910 as amended upto date, and rules issued there under, Regulations of the Fire Insurance Company and relevant BIS Code of Practice.

3 Wiring System

All power wiring shall be carried out with1100 volts grade PVC insulated, armored, overall PVC sheathed aluminium conductor cables for sizes above 6 sq mm. Sizes 6 sq mm and below the power wiring shall be of copper conductor only. Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using 650 volts PVC insulated copper conductor wires in race ways or in conduit. Minimum size of control wiring shall be 1.5 sq mm PVC insulated copper conductor wires. Minimum size of conductor for power wiring shall be 4 sq mm1100 volts grade PVC insulated copper conductor wires in conduit.

4 Construction Features

The control panel shall be metal enclosed sheet steel cubicle, indoor type, dead front, floor mounting / wall mounting type. The control panel shall be totally enclosed, and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. Control panels shall be arranged in multi-tier formation. All doors and covers shall be suitable for double padlocking .All mild steel sheets used in the construction of control panels shall be 14 SWG thick for floor mounted and 16 SWG for wall mounting and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with Plumber metal.

All panels and covers shall be properly fitted and square with the frame and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with hank nuts. self threading screws shall not be used in the construction of control panels. Base channel of 75 mm x 75 mm x 5 mm thick shall be provided at the bottom. Minimum clear space of 300 mm between the floor of control panel and bottom most unit (MCB or Bus Bar) shall be provided.

The control panels shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear. Knockout holes of appropriate size and number shall be provided in the control panels in conformity with the location of incoming and outgoing conduits/cables. All equipment such as meters and indicating lamps etc. shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from top of the control panel. Clamps shall be provided to support the weight of the cables. All power wiring inside the control panel shall be Colour coded and control wiring ferruled for easy identification. Circuit diagram showing the arrangement of circuits shall be pasted on the inside of panel door and covered with transparent plastic sheet and all labeling shall be provided in engraved anodized aluminium /bakelite strips on the front face of the panel board.

5 Circuit Compartment

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the `ON' position. Safety interlocks shall be provided to prevent the breaker or contactor from being drawn out when the breaker is in `ON' position. The door shall not form an integral part of the draw out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6 Instrument Accommodation

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar.

7 Bus Bars and Bus Bar Connections

The bus bar and interconnections shall be of aluminum and of rectangular cross sections suitable for full load current for phase bus bars, and half rated current for neutral bus bar and shall be extensible on either side. The bus bars and interconnections shall be insulated with PVC sleeve / tapes and shall be color coded. Alternatively special insulating paints / materials may be used for the purpose.

All bus bars shall be supported on unbreakable, Non hygroscopic insulated supports at regular intervals, to withstand the forces arising in case of short circuit in the system. All bus bars shall be provided in separate chamber and properly ventilated. All bus bars connections, in main control panels shall be done by drilling holes with cadmium plated / hot dipped galvanized bolts, nuts and washers.

All bus bars connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts.
All connections between the bus bar and breaker, and between breaker and contactor shall be through copper strips of proper size to carry rated current and shall be insulated with PVC sleeves.

8 Raceways

A horizontal race way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

9 Cable compartments

Cable compartment of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate and proper supports shall be provided in cable compartments to support cables.

10 Indications

1. `ON' lamps shall be provided on all outgoing feeders.

2. Cable alley and bus chamber shall be identified on all panels.

11 Rubber Mat

Rubber mat of ISI marked thickness not less than 12 mm shall be provided to cover the full length of front of all panels and rear of panels where back space shall be available for working from the rear.

12 Materials

All materials shall be of the best quality complying with the BIS (Bureau of Indian Standards) specifications. Materials used shall be subject to the approval of the Owner's site representative and samples of the same shall be furnished where required.

a. Moulded Case Circuit Breaker

MCCB shall comprise of switching mechanism, contact system, are extinguishing device and the tripping unit, Contained in a Compact, high strength, heat resistant, flame retardant, insulating Moulded case with high withstand capability against thermal and mechanical stress.

Switching mechanism shall be of Quick Make- Quick Break type and the trip command shall override all other commands. MCCB shall employ maintenance free contact system to minimize the let thru energies while handling abnormal currents.
The handle position shall give positive indication of `ON' `OFF' or tripped.

MCCB shall conform to IS- 2516 (Part I & II/Sec.1) 1985.

b. Miniature Circuit Breaker

Miniature circuit breakers shall be quick make and break type, and shall conform to Relevant Indian Standards. The housing shall be heat resistant and having high impact strength. The fault current shall not be less than 10 KA at 230 V and shall be BIS approved. MCBs shall be flush mounted and shall be provided with trip free manual operating liver and `ON" and OFF" indications. The contacts shall be provided to quench the arc immediately. MCB shall be provided with magnetic thermal releases for over current and short circuit protection. The over load or short circuit device shall have a common trip bar in the case of D P, TP and TPN miniature circuit breakers.

c. Rotary Switches

Switches upto 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism with stop as required. Rotary switches shall have HRC fuse fittings of appropriate rating.

d Selector Switch

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

e. Starters

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant BIS Codes. All Star Delta and ATS Starters shall be fully automatic.
Starter's contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor incase of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta / Reduced Voltage Starters. The insulation for contactor coils shall be of class "B".

Operating coils of contactors shall be suitable for 230 / 415 +10% and (-) 15% volts AC, 50 cycles supply system. The contactors shall drop out when voltage drops to 90% of the rated voltage. The housing of the contactors shall be heat resistant and having high impact strength. Each starter shall have thermal overload protection on all three phases.

f. Over Load Relays

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relays with adjustable setting. Hand-reset button shall be flush with the front door for resetting with starter compartment door closed. Relays shall be directly connected for motors upto 35 HP capacity. C.T operated relays shall be provided for motors above 35 HP capacities. Heater circuit contactors may not be provided with overload relays.

g. Current Transformers

Current transformers shall be of accuracy class I and suitable VA burden for operation of the connected meters and relays. These shall be resin bonded and epoxy coated.

h. Single Phase Preventor

Single phase preventor (current base) shall be provided as per Bill of Quantities and shall be in conformity with relevant BIS Standards. Single phase preventor shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

i. Time Delay Relays

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connections.

j. Indicating Led (22 mm dia) and Metering

All meters and indicating lamps shall be in accordance with BS 37 and BS 39. The meters shall be flush mounted and draw out type. The indicating lamp shall be of LED type. Each main panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three Nos. CTs of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 amps fuse. Other indicating lamps shall be backed up with fuses as called for.

k. Toggle Switch

Toggle switches, where called for, shall be in conformity with relevant BIS Codes and shall be of 5 amps rating.

l. Push Button Stations

Push button stations shall be provided for manual starting and stopping of motors/equipment as called for Green and Red Colour push buttons shall be provided for `Starting' and `Stopping' operations. `Start' or `Stop' indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for `Stop' push buttons. The push button contacts shall be suitable for 6 amps current capacity.

m. Conduits

Conduits shall be of mild steel and shall be hard drawn, stove enameled inside and outside with minimum wall thickness of 1.6 mm for conduits upto 20 mm diameter and 2 mm wall thickness for conduits above 20 mm diameter. GI pull wires shall be installed in the conduit while laying the conduit.

n. Cables

M.V.cables shall be PVC insulated aluminium conductor and armored cables conforming to BIS Codes. Cables shall be armored and suitable for laying in trenches, duct, and on cable trays as required. M.V Cables shall be termite resistant. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armored cables.

o. Wires

1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

13 Cable Laying

Cable shall be laid generally in accordance with BIS Code of Practice. Cables shall be laid on 14 gauge perforated MS sheet cable trays, and cable drops / risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable with drawl / replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks, tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable. 1.1 KV cable shall be buried 600 mm below ground level.

14 Wire Sizes

For all single phase / 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by

means of insulated aluminium conductor wires of adequate size. An isolator shall be provided near each motor / equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminium conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

. The minimum size of control wiring shall be 1.5 Sq.m PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring cabling shall be of the following sizes:

Motor - Selection of cable and switchgear

Motor		Starter Type	Full Load Current (Amp)		Al Cable 3 Core		Contactor Rating AC3 (Amp)	Overload Relay with SPP (Amps)	Earthing (2 nos.)
(HP)	(KW)		Line	Phase	Supply side	Motor side			
1	0.7	DOL	2	2	2.5 sq.mm	2.5 sq.mm	16	1.8 – 2.7	8 SWG GI Wire
2	1.5	DOL	3.5	3.5	2.5 sq.mm	2.5 sq.mm	16	3 - 5	8 SWG GI Wire
3	2.2	DOL	5	5	2.5 sq.mm	2.5 sq.mm	16	4 - 6	8 SWG GI Wire
5	3.7	DOL	7.5	7.5	2.5 sq.mm	2.5 sq.mm	16	6 - 10	8 SWG GI Wire
7.5	5.6	DOL	11	11	4 sq.mm	4 sq.mm	16	10 - 16	8 SWG GI Wire
10	7.5	DOL	14	14	4 sq.mm	4 sq.mm	25	10 - 16	8 SWG GI Wire
12.5	9.3	Star Delta	18	10.4	6 sq.mm	4 sq.mm	25	9 - 15	8 SWG GI Wire
15	11.2	Star Delta	21	12.1	6 sq.mm	4 sq.mm	25	9 - 15	8 SWG GI Wire
20	14.9	Star Delta	28	16.1	10 sq.mm	6 sq.mm	32	14 - 23	8 SWG GI Wire
25	18.6	Star Delta	35	20.2	16 sq.mm	6 sq.mm	32	14 - 23	8 SWG GI Wire
30	22.4	Star Delta	40	23	16 sq.mm	10 sq.mm	40	20 - 33	8 SWG GI Wire
35	26.1	Star Delta	47	26.9	25 sq.mm	10 sq.mm	40	20 - 33	8 SWG GI Wire
40	29.8	Star Delta	55	30.4	25 sq.mm	16 sq.mm	40	28 - 42	6 SWG GI Wire
50	37.3	Star Delta	66	38.1	35 sq.mm	16 sq.mm	40	30 - 50	6 SWG GI Wire
60	44.7	Star Delta	80	46.2	50 sq.mm	25 sq.mm	70	30 - 50	6 SWG GI Wire
75	55.9	Star Delta	100	57.7	70 sq.mm	35 sq.mm	110	45 - 75	6 SWG GI Wire
90	67.1	Star Delta	120	69.2	95 sq.mm	50 sq.mm	110	60 - 100	25mm x 3mm GI Tape
100	74.6	Star Delta	135	77.9	95 sq.mm	50 sq.mm	110	60 - 100 (CT Optd)	25mm x 3mm GI Tape
125	93.2	Star Delta	165	95.3	120 sq.mm	70 sq.mm	200	90 - 150 (CT Optd)	25mm x 3mm GI Tape
150	111.9	Star Delta	200	115.5	185 sq.mm	70 sq.mm	200	90 - 150 (CT Optd)	25mm x 3mm GI Tape

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

15 Drawings

Shop drawings for control panels and wiring of equipment showing the route of conduit/cable shall be submitted by the contractor for approval of Project Managers/ Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

16 Testing

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.

17 Painting

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

18 Labels and Tags

Engraved PVC labels shall be provided on all incoming and outgoing feeders' switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at equipments shall be provided with tags as approved by Project Managers.

19 All panels to have provision for padlocking and all MCCB's/MCB's to have provision for locking in off position.

20 Measurement of Electrical Control Panels

Panels shall be counted as number of units. Quoted rates shall include as lump sum (NOT measurable lengths) for all internal wiring, power wiring and Earthing connections from the control panel to the starter and to the motor, control wiring for inter-locking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate for panel shall also include all accessories, switchgear fuses, contactors, indicating meters and lights as per the specifications.

Section X. Specifications for Fire Hydrant System

1.1 Scope of work

1.1.1 Wet riser fire hydrant system (internal & external)

1.1.2 Valves, suction and delivery connections and headers.

1.1.3 Pipe protection, painting, sleeves & minor civil works other than specifically mentioned in the tender.

1.1.4 Specialized protection as specified.

1.1.5 Testing and commissioning.

1.2. General Requirements

1.2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Managers.

1.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

1.2.3 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.

1.2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

1.2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

1.3 Pipes

1.3.1 All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be GI Pipes as follows:

a. Pipes 150 mm dia and below IS: 1239 or BS: 1387 Heavy Class

b. Pipe 200 mm dia and above IS 3589 of thickness specified.

1.4 Pipe Fittings.

1.4.1 Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are need to complete the piping work in its totality.

1.4.2 Fabricated fittings shall be not be permitted for pipe diameters 50 mm and below.

1.5 Jointing

1.5.1 Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. (With screwed GI forged fittings).

1.5.2 Welded (65 mm dia and above)

Joints between GI and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt-welded joints are not acceptable. Buried pipes will be subject to x ray test from an approved agency at the cost of contractor. (With welded M.S. fittings heavy class with “V” groove).

1.5.3 Flanges.

Flanged joints shall be provided on:

a) Straight runs not exceeding 30 m on pipelines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia or larger diameter.

c) Flanges shall be as per I.S: 6392-1971 Table 17/18 with appropriate number of half thread nuts bolts and make GKW, 3 mm insertion neoprene gasket complete.

1.5.4 Unions

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

1.6 Excavation

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.

Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.

On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.

Contractor shall dispose off all surplus earth with in a lead of 200m or as directed by Project Manager.

1.7 Anchor Thrust Blocks

a) Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.

b) Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.

c) Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.

1.8 Valves

1.8.1 Ball Valves

a) Valves 50 mm dia & below shall be heavy type nickel plated Brass body screwed type with chromium plated brass balls, PTFE Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/sq cm including coupling and gunmetal handle conforming to B.S. 5351 with female screwed ends.

b) All valves shall be approved by the Project Manager before they are allowed to be used on work.

1.8.2 Butterfly Valves

Butterfly Valves shall be cast iron body and shall be of class P.N 16 tested to 20 kg/cm^2 with following details :-

a) Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.

b) The shaft is EN-8 Carbon Steel with low friction nylon bearings.

c) The seat shall be drop tight constructed by bonding resilient electrometer inside a rigid backing.

d) Built in flanged rubber seals.

e) Actuator to level operated for valves above ground and T Key operated for valves below ground.

f) Built in flanges for screwed on flanged connections.

Manufacturer's details on fixing and installation will be followed.

1.8.3 Non Return Valves (NRV) dual plate type non return valves PN 16

a) Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.

b) Non-return valves shall be wafer type check valve with cast iron body and disk, S. Steel pin and hinges, nitrite/neoprene seal, suitable for horizontal/vertical line installation conforming to IS: 5312.

1.8.4 Air vessel / Air Cushion tank.

a) Air cushion tank shall be of size and capacity indicated in schedule of quantities. It shall be provided at the top most point/points and/or in pump house (as specified). The tank shall be complete 25 mm dia. Brass Air Valve (Ball type), Stop Valve (25mm dia), Drain valve (25mm dia) and pressure gauge including 25mm dia. Mild Steel M.S. pipes and fittings, unions, etc. as required to complete the work as per site conditions.

1.8.5 Air Cushion tank shall be measured by numbers and shall include Air Valve, Pressure Gauge, and Globe Valves for testing and draining, M.S. Clamps, Pipes, Fittings, Tees Elbows Union and all other items required completing the work.

1.8.6 Orifice Flanges

Provide orifice flanges fabricated from 6 mm thick stainless steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/cm^2 and allow a discharge of 560 lpm.

1.8.7 Drain Valve

Provide 25 mm dia black steel pipe to IS: 1239 (heavy class) with 25 mm Ball valve for draining any water in the system in low pockets.

1.8.8 Inspection & testing assembly

Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve. The drain pipe beyond the valve upto the drainage point shall be measured with the pipe.

1.8.9. Pump test assembly

Provide on the main fire sprinkler header a 150 mm dia bye pass valve located in an accessible manner along with a rate of flow rotometer calibrated in lpm and able to read 200 % of the rated pump capacity. The delivery shall be connected to the fire tank.

1.8.10 Pressure Gauge

Pressure gauge shall be provided at pump room area and terrace hydrants only. Pressure gauge shall be 100 mm dia gunmetal Bourden type with gunmetal isolation cock, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate level and height for easy readability.

2. Hydrant/valve chambers

2.1 Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick cement plaster inside and outside finished with a

floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.

2.2 Valve chambers shall be 120 x120 cms. For depths up to 100 cms.

3. Fire brigade connections

Provide as shown on drawings separate gunmetal 4 way collecting head with four 63 mm instantaneous type inlets with built in check valves and 150 mm dia outlet connected to the fire and sprinkler main. Collecting head shall be installed on a stand post and provided with horizontal C.I. reflux valve and location to be approved by Project Manager. Provide etched gunmetal label plates with 50mm height letter. The plates should be firmly fixed to the FB connection and any support system.

4. Fire hydrants

4.1 External hydrants

a) Contractor shall provide external hydrants. The hydrants shall be single headed gun metal landing valve with instantaneous type 63 mm dia outlet, controlled by a cast iron butterfly valve installed in underground lockable chambers. The hydrants shall be conforming to I.S. 5290 with bend, M.S. flanged riser of required height to bring the hydrant to correct level above ground.

b) Contractor shall provide for each external fire hydrant station two numbers of 63 mm dia. 15 m long non percolating rubberized fabric lined hose pipes to I.S. 636 Type A with gunmetal male and female instantaneous type coupling to I.S. 903 riveted and bound with 1.5 mm copper wire to hose pipe, fire hose reel, gunmetal branch pipe with nozzle I.S. 903.

4.2 Internal hydrants

a) Contractor shall provide on each landing and other locations as shown on the drawings one single headed gunmetal landing valve with 63 mm dia outlet mounted on a common 80 mm inlet (I.S.5290-1969). Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b) Instantaneous outlets for fire hydrants shall be of standard pattern approved and suitable for fire brigade hoses.

c) Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long non percolating rubberized fabric lined hose pipes to I.S. 636 Type A with gunmetal male and female instantaneous type coupling to I.S. 903 riveted and bound with 1.5 mm copper wire to hose pipe, fire hose reel, gunmetal branch pipe with nozzle I.S. 903.

d) Each hose box shall be conspicuously painted with the letters "FIRE HOSE".

4.3 Fire hose reels

Contractor shall provide standard fire hose reels with 20 mm dia high pressure Dunlop rubber hose 36.5 m long with gunmetal nozzle and control valve, shut off valve, all mounted on circular hose reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall be connected directly to the wet riser. Hose reel shall conform to IS: 884-1969 and rubber hose to IS: 5132.

4.4 Hose Cabinets

a. Provide hose cabinets for all internal fire hydrants. Hose cabinets shall be fabricated from 16 gauge M.S. sheet of fully welded construction with hinged double front door partially glazed with locking arrangement, stove enameled

fire red paint with "FIRE HOSE" written on it prominently.(Size as given in the Bill of Quantities).

4.5 Pipe protection

a) All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.

b) Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4 mm thick PYPCOTE or equivalent multi-layer sheet as per standard manufacturer's specifications.

4.6 Pipe Supports

a) All pipe clamps and supports shall be galvanized steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

b) Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally accounted.

Pipe Spacing Table

		<---------- Pipe commercial dia. -----					----------	----------	------→
S.No.	**Pipes & Position**	15/20	20/25	32/40	50	75/80	100/110	150/160	200
1	**Vertical**								
1.1	GI /MS	2.4	2.4	3	3.6	4.5	4.5	5.4	5.4
1.2	CI Pipes IS 1729/3989	X	x	<---------- 3 m ----------				----------	-------→
1.3	CI Heavy Duty IS 1536	X	x	<---------- 3.6 m ----------				----------	-------→
1.4	uPVC SWR Systems	X	x	0.5	0.7	0.9	0.9	1.0	
1.5	uPVC Water Supply								
1.6	Polybutylene	<-----As per manufacturer's Recommendations					----------	----------	-------→
1	**Horizontal**								
1.1	GI /MS	2.0	2.0	2.4	3.0	3.6	4.0	4.5	4.5
1.2	CI Pipes IS 1729/3989			<----------3 m ---------->					
1.3	CI Heavy Duty IS 1536					3.0	3.6	3.6	4.5
1.4	uPVC SWR Systems				1.2	1.8	1.8	1.8	
1.5	uPVC Water Supply								
1.6	Polybutylene	<-As per manufacturer's recommendations---->							

4.7 Testing

a. All piping in the system shall be tested to a hydrostatic pressure of 1.5 times the working pressure or 20 kg/sq.cm(whichever is more) without drop in pressure for at-least 2 hours.

b. Rectify all leakages, make adjustments and retest as required and directed.

4.8 Cables

a. Contractor shall provide control cables from supervisory valves and switches to the annunciation panels.

b. All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 volt grade.

c. All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's

name.

d. All cable joints shall be made in an approved manner as per standard practice.

Cable Trays

i All cables shall be routed in approved locations in coordination with all other services in a proper manner.

ii Cable trays shall be of galvanized steel and hung from the ceiling by galvanized rods supported by appropriate size and type of expandable expansion fasteners drilled into the slabs and walls by an electric drill.

4.9. Measurement

a. Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings, flanges, and welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.

b. Sluice and full way valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.

c. Fire hydrants, hose reels, fire brigade connections, orifice flanges shall be measured by number and include all items given in the specifications and bill of quantities.

d. Fire hose and boxes specified shall be measured by number and include all items given in specifications and Bill of Quantities.

e. Fire extinguishers shall be measured by number and shall include full charge.

f. Cables and cable trays shall be measured per linear meter shall include clamps, hangers, anchor fasteners complete in all respects.

Section - XI Specifications forFire Sprinkler System

1 Scope of work

1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances including scaffolding,M.S. ladders etc. necessary and required to completely install wet riser fire hydrant and sprinkler system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

1.2 Without restricting to the generality of the foregoing, the work shall include but not limited to the following:-

a) Piping for Sprinkler systems.

b) Sprinkler heads, spare sprinklers

c) Inspection & test assemblies and accessories

2. General

2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Manager.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

2.3 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.

2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.

2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

3 Pipes

a) All pipes within and outside the building in exposed locations and shafts includingconnections buried under floor shall be GI. pipes as follows:

b) Pipes 150 mm dia and below IS: 1239/ BS: 1387 Heavy Class

4 Pipe Fittings

a) Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. and all
Such connecting devices that are need to complete the piping work in its totality.

b) Screwed fittings shall be approved type malleable or cast iron fittings suitable for screwed joints.

c) Forged steel fittings of approved type with "V" groove for welded joints.

d) Fabricated fittings shall be not being permitted for pipe diameters 50 mm and below.

5 Jointing

5.1 **Screwed (50 mm dia pipes and below)**
Joint for black steel pipes and fittings shall be metal to metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

5.2 **Welded (65 mm dia and above)**

Joints between M.S. and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt welded joints are not acceptable.

5.3 **Flanged**

Flanged joints shall be provided on:

a) Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger Diameter.

c)For jointing all types of valves, appurtenances, pumps, connections with other Type of pipes, to water tanks and other places necessary and required as Good for engineering practice.

d)Flanges shall be as per I.S. with appropriate number of G.I. nuts and bolts, 3 mm Insertion neoprene gasket complete.

5.4 **Unions**

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

6 Excavation

6.1 Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.

6.2 Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.

6.3 On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.

6.4 Contractor shall dispose of all surplus earth within a lead of 200 m or as directed by Project Manager.

7 Anchor Thrust Blocks

a) Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.

b) Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.

c) Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.

8 Valves

8.1 **Cast IronButterfly Valves**

8.1.1 Valves 50 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

8.1.2 Butterfly valves shall be of best quality conforming to I.S.13095 of class specified.

8.3 **Non-return valves (Check Valves)**

Non-return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS: 5312.

8.4 **Air valves**

Provide 25 mm dia screwed inlet cast iron single acting air valve, on all high points in the system or as shown on drawings.

8.5 **Orifice Flanges**

Provide orifice flanges fabricated from 6 mm thick stainless steel plate to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/cm^2 and allow a discharge of 560 lpm. The contractor shall submit design of the orifice flanges for approval before installation.

8.6 **Drain Valve**

Provide 50 mm dia black steel pipe to IS: 1239 (heavy class) with 50 mm gunmetal fullway valve for draining any water in the system in low pockets.

8.7 **Inspection & testing assembly**

Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, and bye-pass valve. The drain pipe beyond the valve upto the drainage point shall be measured with the pipe.

9. **Pipe protection**

a) All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.

b) Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4 mm thick PYPCOAT multilayer sheet as per standard manufacturer's specifications.

10. **Pipe Supports**

10.1 All pipe clamps and supports shall be galvanized steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

10.2 Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fasteners or equivalent). The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encounter.

11 **Sprinkler Heads**

11.1 Sprinkler heads shall be quartzoid bulb type with gunmetal body fully approved and having current certification of the fire laboratory of the C.B.R.I. Roorkee, Underwriter's laboratory (UL) and under the approved certified list of the Fire Office Committee (FOC) of U.K. or NFPA of USA. Any one of the certification as acceptable to the local fire authorities obtained prior to the procurement and approved and accepted by the Project Manager.

11.2 Sprinkler heads shall be installed in conformity with approved shop drawings and in co-ordination with electrical fixtures, ventilation ducts, cable galleries and other services along the ceiling.

11.3 Following type of sprinklers shall be used:

S.No.	Type of Sprinkler	Temp rating ^{0}C

1. Pendant or upright 68

2. Special application quick wall Type with throw suitable for Room size of 5 m length (Extended type) 68

3. Semi concealed type 68
(Recessed in rosette)

11.4 Spacing and coverage of sprinkler shall be in accordance with risk classification of area in which they are installed, design density and TAC regulation.

12 **Spare Sprinklers**

a) Provide lockable enamel painted steel cabinet including following type of spare sprinklers

i) Semi concealed type, Pendent or Upright type.

b) The cabinet should also contain one pair of wrenches (of each size of the same are different) for the sprinklers.

c) Spare sprinklers shall be of the same specifications as that of the original sprinklers specified.

13 **Testing**

13.1 All piping in the system shall be tested to a hydrostatic pressure of 14 kg/cm^2 without drop in pressure for at least 8 hours.

13.2 Rectify all leakages, make adjustments and retest as required and directed.

14. **Measurement**

14.1 Mild steel pipes shall be measured per linear meter of the finished length and shall include all fittings, flanges, and welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.

14.2 Butterfly valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.

14.3 Fire extinguishers shall be measured by number and shall include full charge.

14.4 Spare sprinkler cabinets with spare sprinklers specified and spanners shall be measured as per actual item given in the specifications and Bill of Quantities.

14.5 Sprinkler heads shall be measured by numbers.

1 Scope of Work

1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps as required by the drawings and specified hereinafter or given in the schedule of quantities.

1.2 Without restricting to the generality of the foregoing, the pumps and ancillary equipment shall include the following:-

a) Electrically operated and diesel driven pumps with motors, base plates and accessories.

b) Alarm system with all accessories wiring and connections

c) Pressure gauges with isolation valves & piping bleed and block valves.

d) M.S. pipes, valves, suction strainers, delivery headers & accessories.

e) Foundations, vibration eliminator pads and foundation bolts.

2 General Requirements

i) Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.

ii) Pumps and motors shall be truly aligned by suitable instruments.

iii) All pump connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.

iv) Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.

a) Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The Contractor shall provide facilities to the Project Manager or their authorized representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer’s works without any cost to the owners.

b) Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.

c) Provide vibration eliminating pad and connectors for each pump.

d) The Contractor shall submit with this tender a list of recommended spare parts for two years of normal operation and quote the prices for the same.

3 Fire, Sprinkler & Jockey Pumps

3.1 Pumping Sets

a) Pumping sets shall be single stage single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be of stainless steel with bronze sleeve and grease lubricated bearings.

b) Pumps shall be connected to the drive by means of spacer type love joy couplings which shall be individually balanced dynamically and statically.

c) The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.

3.2 Pumps shall be provided with approved type of mechanical seals.

3.3 Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65%

of the rated head. The shut off head shall not exceed 120% of the rated head.

3.4 The pump shall meet the requirements of the Tariff Advisory Committee and the unit shall be design proven in fire protection services.

4 Electric drive

4.1 Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.

4.2 Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

4.3 Motors shall be wound for class B insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.

4.4 Motors for fire pumps shall meet all requirements and specifications of the Tariff Advisory Committee.

4.5 Motors shall be suitable for 415±10% volts, 3 phase 50 cycles a/c supply and shall be designed for 38 deg C ambient temperature. Motors shall conform to I.S. 325.

4.6 Motors shall be designed for two start system.

4.7 Motors shall be capable of handling the required starting torque of the pumps.

4.8 Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.

4.9 Speed of the motor shall be compatible with the speed of the pump.

5 Diesel Engine

5.1 Diesel engine shall be of 6 cylinders with individual head assemblies. The engine shall be water cooled and shall include heat exchanger and connecting piping, strainer, isolating & pressure reducing valves, bye-pass line complete in all respects.

5.2 Engine shall be direct injection type with low noise and exhaust emission levels.

5.3 The speed of the engine shall match the pump speed for direct drive.

5.4 The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg.C. and shall take full load within 15 seconds from the receipt of the signal to start.

5.5 The engine shall efficiently operate at 38 deg.C ambient temperature at 50 meters above mean sea level.

5.6 Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 meters distance.

5.7 The engine shall be self-starting type upto 4 deg C and shall be provided with one 24 volts heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One additional spare battery shall be provided. The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.

5.8 A battery re-charger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator shall be provided.

5.9 The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.

5.10 Engine shall be suitable for running on high speed diesel oil.

5.11 The system shall be provided with a control panel with push button starting arrangement also and wired to the engine on a differential pressure gauge.

5.12 The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.

5.13 One self supported one day oil tank fabricated from 5 mm thick MS sheet electrically welded with a capacity of 8 hours working load but not less than 200 lit shall be provided. Level indicating gauge glass on the day oil tank and low fuel level indication on the control panel shall also be provided.

5.14 One exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions shall be provided.

5.15 All other accessories fittings & fixtures necessary and required for a complete operating engine set shall be provided.

5.16 Contractor shall indicate special requirements, if any, for the ventilation of the pump room.

5.17 The materials of construction for the major components are as follows:

Casting : Cast iron
Impeller : Bronze
Shaft : EN-8
Wear Rings : Bronze
Gland Packing : Graphite Asbestoc
Type of Bearing : Ball bearing/Roll Bearing
Type of coupling: Flexible couplings

5.18 Instrumentation

The diesel engine shall be provided with the following instrumentation:

a) Temperature indicator in cooling water inlet and outlet
b) Temperature indicator in lubricating oil outlet from the oil cooler
c) Pressure gauge for lubricating oil system
d) Speed indicator
e) Lubricating oil sump level indicator
f) Fuel oil tank level indicator
g) Voltmeter and ammeter in battery charging circuit
h) Cooling water high temperature alarm
i) Oil pressure low alarm

A local instrument panel shall be provided with the engine for mounting all the above instruments and annunciation.

5.19 Pumps and motor engine shall be mounted on a common base frames fabricated from M.S. structural and placed in suitable concrete foundations with the help of approved cushy foot mountings (Anti-vibration pads) to avoid vibrations. The anti-vibration pads shall be of heavy duty type.

6 Air Vessel

6.1 Provide one air vessel fabricated from 10 mm M.S. plate with dished ends 8 mm thick shell and suitable supporting legs. Air vessel shall be provided with a 50 mm dia connection from pump, one 25 mm dia drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 250 mm dia x 1000 mm high and tested to 20 kg/sq cm pressure.

6.2 The fire pumps shall operate on drop of pressure in the mains as given in Para 3.6.3 below. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

6.3 Operating conditions for fire pumps.

a)	Operating pressure	7.5 Kg/sq cm	
		Cut in	Cut out
b)	Jockey pump	6.5 kg/sq cm	7.5 kg/Sq.Cm
c)	Fire Electric Pump Hydrant	5.5 Kg/sq cm	Manual
d)	Diesel Engine Driven Pump	4.0 kg/sq cm	Manual

Notes:

a) Jockey pump shall start and stop through pressure switch automatically.

b) Jockey pump shall stop when main pump starts.

Main pumps shall start automatically on fall of pressure but stopping shall be manual.

7 Vibration Eliminators

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufactures details.

8 Measurements:

8.1 Fire, sprinkler pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities.

8.2 Air vessel, fire alarm, installation valve, sluice valves, non-return valves, vibration eliminators, flanges and suction strainer shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications.

8.3 Pump headers, shall be measured per linear meter and shall include all items given in the specifications and schedule of quantities.

Section XIII Hand Appliances

1 Scope of work

1.1 Work under this section shall consist of furnishing all labour, material, appliances and equipment necessary and required to install fire extinguishing hand appliances.

1.2 Without restricting to the generality of the foregoing the work shall consist of the following:-

Installation of fully charged and tested fire extinguishing hand appliances CO_2, foam, dry chemical powder type as required by these specifications and drawings.

2 General requirements

2.1 Fire extinguishers shall conform to the following Indian Standard Specifications and shall be with ISI approved stamp as revised and amended up to date:-

a)	CO_2 type	I.S. 2878
b)	Dry powder type (Stored pressure)	I.S.13849

2.2 Fire extinguishers shall be installed as per Indian Standard "Code of Practice for Selection, Installation and Maintenance of Portable First Aid Appliances" I.S.2190-1962.

2.3 Hand appliances shall be installed in readily accessible locations with the appliance brackets fixed to wall by suitable anchor fasteners.

2.4 Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

2.5 All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

3 Measurement

Fire extinguishers shall be measured by numbers and include installation and all items necessary and required and given in the specifications.

Section XIV Commissioning and Guarantees (Fire Fighting System)

1 Scope of work

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

2 General requirements:

2.1 The rates quoted in this tender shall be inclusive of the works given in this section.

2.2 Contractor shall provide al tools equipment, metering and testing devices required for the purpose.

2.3 On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

3 Pre-commissioning

3.1 On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices, the contractor shall proceed as follows:-

A Fire protection system:

i) Check all hydrant valves and close if any valve is open. Also check all suction and delivery connections are properly made.

ii) Test run and check rotation of each motor and correct the same if required.

B Pipe work

i) Check all clamps, supports and hangers provided for the pipes.

ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

4 Commissioning & Testing

A. Fire hydrant system

i) Pressurize the fire hydrant system by running the main Electric Driven fire pump and after attaining the required pressure shutoff the pump.

ii) Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump should cut-in at the pre-set pressure and should not cutout automatically on reaching the normal line pressure. The fire pump should stop only by manual push button.

iii) Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.

iv) When the fire pumps have been checked for satisfactory working on automatic controls, open five hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage. The electrically driven pump should run continuously for eight hours so that its performance can be checked.

v) 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 does not fit into the other properly shall be replaced by the contractor. Landing valves shall also be checked by opening and closing under pressure.

B. Handing over

1) All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager, and the job handed over to the Project Manager, or his authorized representative.

2) Contractor shall also hand over, to the Project Manager, all maintenance & operation manuals and all other items as per the terms of the contract.

C. Guarantees

1) The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.

2) The form of warranty shall be as approved by the Project Manager.

3) The warranty shall be valid for a period of one year from the date of commissioning and handing over.

4) The warranty shall expressly include replacement of all defective or under capacity equipment. Project Manager may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.

5) The warranty shall include replacement of any equipment found to have capacity lesser that the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Project Manager.

Section XV I.S. CODES AND REFERENCE STANDARDS.

A. Codes and reference standards referred to in the contract shall be understood to form a part of the contract.

B. Alternative reference standards produced by different standards authorities may be specified in a Section. Standards of any of the specified authorities may be acceptable, however, materials specified in the Section shall be incorporated in the works from only one of the specified standards authority to ensure compatibility in the performance of the materials.

C. The contractor shall be responsible for adherence to reference standard requirements by subcontractors and suppliers.

D. Where edition date is not specified, consider that reference to manufacturer's and published codes, standards and specifications are made to the latest edition (revision or amendment) approved by the issuing organization current at issue date of the Tender.

E. The specified reference standards are **INDIAN STANDARD CODES** and are intended to establish the quality of materials and workmanship required for the works. Reference standards published in other countries may, in the sole judgment of the owner's consultant, also be acceptable providing that the Contractor furnishes sufficient data for the Owner's Consultant to determine if the quality of materials and workmanship at least equals or exceeds all tests prescribed by the specified reference Indian Standards codes.

Such other reference standards published by the following will be considered;

BSI	:	British Standards Institute
AFNOR	:	Association Francise de Normalization (French Standards Institute)
DIN	:	Deutsche Industries Norman (German Standards)
ANSI	:	American National Standards Institute
ASTM	:	American Society for Testing and Materials

F. Reference standards and specifications are quoted in the specification to establish minimum standards. Works of quality or of performance characteristics that exceed these minimum standards will be considered to confirm.

Should regulatory requirements or the contract conflict with specified reference standards or specifications, the more stringent in each case shall govern.

G. Where reference is made to manufacturer's directions, instructions or specifications they shall include full information on storing, handling, preparing, mixing, installing, erection, applying or other matters concerning the materials pertinent to their use in the works and their relationship to materials with which they are incorporated.

H. Obtain copies of codes applying to the Work, manufacturer’s directions and reference standards referred to in the contract within 90 days of signing the contract.

I. Submit a copy of each code, reference standard and specification, and manufacturer's directions, instructions and specifications, to which reference is made in the specification to the Owner's Authorized Representative's.

J. **LIST OF CODES (INDIAN STANDARD CODES)**

Standards, specifications, associations, and regulatory bodies are generally referred to throughout the specifications by their abbreviated designations. The materials workmanship shall be in accordance with the requirement of the appropriate CP, I.S code wherever applicable together with any building regulations or bye-laws governing the works.

The following list is included for guidance only and the omission of any CP, I.S. codes from the list does not relieve the contractor from compliance therewith:

The more important Codes, Standards and Publications applicable to this section are listed hereinafter:

1. **General**

SP : 6 (1)	Structural Steel Sections
IS : 27	Pig Lead
IS : 325	Three Phase Induction Motors
IS : 554	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 694	PVC insulated cables for working voltages upto & including 1100 V.
IS : 779	Specification for water meters (domestic type).
IS : 782	Specification for caulking load.
IS : 800	Code of practice for general construction in steel
IS : 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
IS : 1172	Code of Basic requirements for water supply drainage and sanitation.
IS : 1367 (Part 1)	Technical supply conditions for threaded steel fasteners: Part 1 introduction and general information.
IS : 1367 (Part 2)	Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances.
IS : 1554 (Part 1)	PVC insulated (heavy duty) electric cables: Part 1 for working voltages upto and including 1100 V.
IS : 1554 (Part 2)	PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 KV upto and including 11 KV.
IS : 1726	Specification for cast iron manhole covers and frames.
IS : 1742	Code of practice for building drainage.
IS : 2064	Selection, installation and maintenance of sanitary appliance code of practice.
IS : 2065	Code of practice for water supply in buildings.
IS : 2104	Specification for water meter for boxes (domestic type)
IS : 2373	Specification for eater meter (bulk type)
IS : 2379	Colour code for identification of pipe lines.
IS : 2629	Recommended practice for hot dip galvanizing on iron and Steel.
IS : 3114	Code of practice for laying of cast iron pipes
IS : 4111 (Part 1)	Code of practice for ancillary structures in sewerage system : Part 1 manholes.

IS : 4127	Code of practice for laying glazed stoneware pipes.
IS : 4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes.
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5455	Cast iron steps for manholes.
IS : 6159	Recommended practice for design and fabrication of material, prior to galvanizing.
IS : 7558	Code of practice for domestic hot water installations.
IS : 8321	Glossary of terms applicable to plumbing work.
IS : 8419 (Part 1)	Requirements for water filtration equipment: Part 1 Filtration medium sand and gravel.
IS : 8419 (Part 2)	Requirements for water filtration equipment: Part 2 under drainage system.
IS : 9668	Code of practice for provision and maintenance of water supplies and fire fighting.
IS : 9842	Preformed fibrous pipe insulation.
IS : 9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.
IS : 10221	Code of practice for coating and wrapping of underground mild steel pipelines.
IS : 10446	Glossary of terms relating to water supply and sanitation.
IS : 11149	Rubber Gaskets
IS : 11790	Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings.
IS : 12183 (Part 1)	Code of practice for plumbing in multistoried buildings : Part 1 water supply.
IS : 12251	Code of practice for drainage of building basements.
IS : 5572	Code of practice for sanitary pipe work.
BS : 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.
BS : 8301	Code of practice for building drainage.
BSEN : 274	Sanitary tap were, waste fittings for basins, bidets and baths. General technical specifications.

2. **Pipes and Fittings**

IS : 458	Specification for precast concrete pipes (with and without reinforcement)
IS : 651	Salt glazed stone ware pipes and fittings.
IS : 1239 (Part 1)	Mild steel, tubes, tubular and other wrought steel fittings : Part 1 Mild Steel tubes.
IS : 1239 (Part 2)	Mild Steel tubes, tubular and other wrought steel fittings: Part 2 Mild Steel tubular

and other wrought steel pipe fittings.

IS : 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast Iron fittings for pressure pipes for water, gas and sewage.
IS : 1729	Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 1879	Malleable cast iron pipe fittings.
IS : 1978	Line pipe
IS : 1979	High test line pipe.
IS : 2501	Copper tubes for general engineering purposes
IS : 2643 (Part 1)	Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions.
IS : 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Part 2 Tolerances.
IS : 2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes.
IS : 3468	Pipe nuts.
IS : 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS : 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4346	Specifications for washers for use with fittings for water services.
IS : 4711	Methods for sampling steel pipes, tubes and fittings.
IS : 6392	Steel pipe flanges
IS : 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS : 7181	Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

3. **Valves**

IS : 778	Specification for copper alloy gage, globe and check valves for water works purposes.
IS : 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS : 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS : 2906	Specification for sluice valves for water works purposes (350 mm to 1200 mm size)
IS : 3950	Specification for surface boxes for sluice valves.

IS : 5312 (Part 1)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 5312 (Part 2)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 12992 (Part 1)	Safety relief valves, spring loaded : Design
IS : 13095	Butterfly valves for general purposes.

4. **Sanitary Fittings**

IS : 771 (Part 1 to 3)	Specification for glazed fire clay sanitary appliances.
IS : 774	Specification for flushing cistern for water closets and urinals (other than plastic cistern)
IS : 775	Specification for cast iron brackets and supports for wash basins and sinks
IS : 781	Specification for cast copper alloy screw down bib taps and stops valves for water services.
IS : 1700	Specification for drinking fountains.
IS : 2548 (Part 2)	Specification for plastic seats and covers for water closets: Part 1 Thermo set seats and covers.
IS : 2556 (Part 1)	Specification for vitreous sanitary appliances (Vitreous china) : Part 1 General requirement.
IS : 2556 (Part 2)	Specification for vitreous sanitary appliances (vitreous china): Part 2 Specific requirements of wash-down water closets.
IS : 2556 (Part 3)	Specification for vitreous sanitary appliances (vitreous china): Part 3 Specific requirements of squatting pans.
IS : 2556 (Part 4)	Specification for vitreous sanitary appliances (vitreous china): part 4 specific requirements of wash basins.
IS : 2556 (Part 6 Sec 2)	Specification for vitreous sanitary appliances (vitreous china): part 6 Specific requirements of urinals, section 2 half stall urinals.
IS : 2556 (Part 6 Sec 4)	Specification for vitreous sanitary appliances (vitreous china): Part 6 specific requirements of urinals, section 4 partition slabs.
IS : 2556 (Part 6 Sec 5)	Specification for vitreous sanitary appliances (vitreous china): Part 6 Specific requirements of urinals, section 5 waste fittings.
IS : 2556 (Part 6 Sec 6)	Specification for vitreous sanitary appliances (vitreous china) : Part 6 Specific requirements of urinals, section 6 water spreaders for half stall urinals.
IS : 2556 (Part 7)	Specification for vitreous sanitary appliances (vitreous china) : Part 7 Specific requirements of half round channels.
IS : 2556 (Part 8)	Specification for vitreous sanitary appliances (vitreous china): Part 8 Specific requirements of siphoning wash down water closets.
IS : 2556 (Part 11)	Specification for vitreous sanitary appliances (vitreous china): Part 11 Specific

	requirements for shower rose.
IS : 2556 (Part 12)	Specification for vitreous sanitary appliances (vitreous china): Part 12 Specific requirements of floor traps.
IS : 2556 (Part 15)	Specification for vitreous sanitary appliances (vitreous china): Part 15 Specific requirements of universal water closets.
IS : 2692	Specification for ferrule for water services
IS : 2717	Glossary of terms relating to vitreous enamelware and ceramic metal systems
IS : 2963	Specifications for waste plug and its accessories for sinks and wash basins.
IS : 3311	Specification for waste plug and its accessories for sinks and wash basins.
IS : 5961	Specification for cast iron gratings for drainage purposes.
IS : 6249	Specification for gel-coated glass fiber reinforced polyester resin bath tubs.
IS : 6411	Specification for gel-coated glass fiber reinforced polyester resin bath tubes.
IS : 8931	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.
IS : 9758	Specification for flush valves and fitting for water closets and urinals.

5. **Pumps & Vessels**

IS : 1520	Specification for horizontal centrifugal pumps for clear cold fresh water.
IS : 2002	Steel plates for pressure vessels for intermediate and high temperature service including boilers.
IS : 2825	Code for unfired pressure vessels.
IS : 4648 (Part 1)	Code of practice for lining of vessels and equipment for chemical processes Part 1 : Rubber lining.
IS : 5600	Specification for sewage and drainage pumps
IS : 8034	Specification for submersible pump sets for clear, cold, fresh water.
IS : 8418	Specification for horizontal centrifugal self-priming pumps.

6 **Fire Fighting Equipment**

SP:7	Amendment No. III to NBC Part-IV Fire Protection Jan 1997
TAC	Tariff Advisory Committee fire protection manual Part-I.
TAC	Rules of Tariff Advisory Committee for automatic sprinkler system.
NFPA : 12 , 1993	Standards on Carbon Dioxide Extinguishing System
IS : 636	Non-percolating flexible fire fighting delivery hose.
IS : 884	Specification for first aid hose reel for fire fighting.

IS : 901	Specification for couplings, double male and double female, instantaneous pattern for fire fighting.
IS : 902	Suction hose couplings for fire fighting purposes.
IS : 903	Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner.
IS : 904	Specification for 2-way and 3-way suction collecting heads for fire fighting purposes.
IS : 907	Specification for suction strainers, cylindrical type for fire fighting purposes.
IS : 908	Specification for fire hydrant, stand post type.
IS : 909	Specification for underground fire hydrant, sluice valve type.
IS : 910	Specification for portable chemical foam fire extinguisher.
IS : 933	Specification for portable chemical foam fire extinguisher.
IS : 1648	Code of practice for fire safety of building (general) : Fire fighting equipment and its maintenance.
IS : 2171	Specification for portable fire extinguishers dry powder (cartridge type)
IS : 2190	Selection, installation and maintenance of first aid fire extinguishers – Code of practice.
IS : 2871	Specification for branch pipe, universal, for fire fighting purposes.
IS : 2878	Specification for fire extinguishers, carbon dioxide type (portable and trolley mounted).
IS : 3844	Code of practice for installation and maintenance of internal fire hydrants and hose reel on premises.
IS : 5290	Specification for landing valves.
IS 5714	Specification for coupling, branch pipe, nozzle, used in hose reel tubing for fire fighting.
IS : 8423	Specification for controlled percolation type hose for fire fighting.
IS : 10658	Specification for higher capacity dry powder fire extinguisher (trolley mounted).
IS : 11460	Code of practice for fire safety of libraries and archives buildings.
IS : 1309	External hydrant systems – Provision and maintenance – Code of practice.
IS : 5514 (Parts 1 to 7)	Reciprocating internal combustion engines : Performance.

7. **Pipes and Fittings**

IS : 458	Specification for precast concrete pipes (with and without reinforcement)

IS : 1239 (Part 1)	Mild steel, tubes, tubulars and other wrought steel fittings: Part 1 Mild Steel tubes.
IS : 1239 (Part 2)	Mild Steel tubes, tubulars and other wrought steel fittings: Part 2 Mild Steel tubulars and other wrought steel pipe fittings.
IS : 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast Iron fittings for pressure pipes for water, gas and sewage.
IS : 1729	Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 1879	Malleable cast iron pipe fittings.
IS : 1978	Line pipe
IS : 1979	High test line pipe.
IS : 2643 (Part 1)	Dimensions for pipe threads for fastening purposes : Part 1 Basic profile and dimensions.
IS : 2643 (Part 2)	Dimensions for pipe threads for fastening purposes : Part 2 Tolerances.
IS : 2643 (Part 3)	Dimensions for pipe threads for fastening purposes : Part 3 Limits of sizes.
IS : 3468	Pipe nuts.
IS : 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS : 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4346	Specifications for washers for use with fittings for water services.
IS : 4711	Methods for sampling steel pipes, tubes and fittings.
IS : 6392	Steel pipe flanges
IS : 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS : 7181	Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

8. **Valves**

IS : 778	Specification for copper alloy gage, globe and check valves for water works purposes.
IS : 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS : 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS : 2906	Specification for sluice valves for water works purposes (350 mm to 1200 mm size)

IS : 3950	Specification for surface boxes for sluice valves.
IS : 5312 (Part 1)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 5312 (Part 2)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 12992 (Part 1)	Safety relief valves, spring loaded : Design
IS : 13095	Butterfly valves for general purposes.
IS : 27	Pig Lead
IS : 325	Three Phase Induction Motors
IS : 554	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 694	PVC insulated cables for working voltages upto & including 1100 V.
IS : 779	Specification for water meters (domestic type).
IS : 782	Specification for caulking load.
IS : 800	Code of practice for general construction in steel
IS : 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
IS : 1367 (Part 1)	Technical supply conditions for threaded steel fasteners: Part 1 introduction and general information.
IS : 1367 (Part 2)	Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances.
IS : 1554 (Part 1)	PVC insulated (heavy duty) electric cables: Part 1 for working voltages upto and including 1100 V.
IS : 1554 (Part 2)	PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 KV upto and including 11 KV.
IS : 1726	Specification for cast iron manhole covers and frames.
IS : 2104	Specification for water meter for boxes (domestic type)
IS : 2373	Specification for eater meter (bulk type)
IS : 2379	Colour code for identification of pipe lines.
IS : 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS : 2629	Recommended practice for hot dip galvanizing on iron and Steel.
IS : 3114	Code of practice for laying of cast iron pipes
IS : 4853	Recommended practice for radiographic inspection of fusion welded butt joints

	in steel pipes.
IS : 5455	Cast iron steps for manholes.
IS : 6159	Recommended practice for design and fabrication of material, prior to galvanizing.
IS : 8321	Glossary of terms applicable to plumbing work.
IS : 9668	Code of practice for provision and maintenance of water supplies and firefighting.

TECHNICAL SPECIFICATIONS :

PART-III (ELECTRICAL)

LT CABLES & CABLE TRAYS:

STANDARDS OF CODES

This chapter covers the specifications for supply and laying of Medium Voltage XLPE cables.

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended up to date. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and /or IEC Standards shall be applicable.

CABLES

Medium voltage cables shall be aluminum conductor XLPE insulated, PVC sheathed armored conforming to latest IS. Cables shall be rated for a 1100 Volts.

Conductors shall be insulated with high quality XLPE base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied below outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

1 Core	:	Red/Black/Yellow/Blue
2 Core	:	Red and Black
3 Core	:	Red, Yellow and Blue
3 ½ /4 Core	:	Red, Yellow, Blue and Black

LAYING

Cables shall be laid as per the specifications given below :

Duct system

Wherever specified such as road crossing, entry to building or in paved area etc. cables shall be laid in underground ducts. The duct system shall consists of a required number of stone ware pipes, GI, CI or spun reinforced concrete pipe with simplex joints and all the jointing work shall be done according to the CPWD building specifications or as per the instructions of the Engineer-In-Charge as the case may be. The size of the pipe shall not be less than 100mm in diameter for a single cable and shall not be less than 150mm for more than one cable and so on. The pipe shall be laid directly in ground without making any special bed but wherever asbestos cement pipes are used, the pipes shall be encased in concrete of 75mm thick. The ducts shall be properly anchored to prevent any movement. The top surface of the cable ducts shall not be less than 60 cm. below the ground level. The ducts shall be laid a gradient of at least 1:300. The duct shall be provided manholes of adequate size at regular intervals for drawing the cables. The manhole cover and frame shall be of cast iron and machine finished to ensure a perfect joint. The manhole covers shall be installed flush with the ground or paved surfaces. The duct entry to the manholes shall be made leakproof with lead-wool joints. The ducts shall be properly plugged at the ends to prevent entry of water, rodents, etc. Suitable duct markers shall be placed along the run of the cable ducts. The duct markers shall at least be 15 cm. square embedded in concrete, indicating duct. Suitable cable supports made of angle iron shall be provided in the manholes for supporting the cables. Proper identification tags shall be provided for each cable in the manholes.

Cables in outdoor trenches

Cable shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 75cm from the final ground level. The width of the trenches shall not be less than 45 cm. However, where more than one cable is laid, an axial distance of not less than 15 cm. shall be allowed between the cables. The trenches shall be excavated in reasonably straight line with vertical side walls and with uniform depth. Wherever there is a change in direction suitable curvature shall be provided complying with the requirements. Suitable shoring and propping may be done to avoid caving in of trench walls. The bottom of the trench shall be level and free from stone brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8 cm. in depth.

The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be paved of in one stretch. However where this is not possible the remainder of the cable may be removed by "Flaking" i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 mtrs. apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

For short cut runs and sizes upto 50 sq.mm of cables upto 1.1 KV grade any other suitable method of direct handling and laying can be adopted with the prior approval of the Engineer-in-charge.

When the cable has been properly straightened, the cores are tested for continuity and insulation resistance and the cable length then measured. The ends of all cables shall be sealed immediately. In case of PVC cables suitable moisture seal tape shall be used for this purpose.

Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less 17 cms above the base cushion of sand before the protective cover is laid. In the case of vertical multi tier formation after the first cable has been laid, a sand cushion of 30 cms shall be provided over the initial bed before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30 cms as stated above. The top most cable shall have final sand covering not less than 17 cms before the protective cover is laid.

Unless otherwise specified, the cables shall be protected by the second class bricks of not less 20 cms x 10 cms x 10 cms (nominal size) protection covers placed on top of the sand (bricks to be laid breadth wise) for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at 5 cm. over the sides of the end cables. The trenches shall be taken back filled with excavated earth free from stones or other sharp edge debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm, unless otherwise specified.

Route Marker

Cable route marker marked "Cable" shall be provided along with the route of the cable and location of loops. The route markers shall be of tapered concrete slab of 60 x 60cm at bottom and 50 x 50cm at top having a thickness of 10cm. Cable marker shall be mounted parallel to and 50cm away from the edge of the trench.

Cables in indoor trenches

Cables shall be laid in indoor trenches wherever specified. The trench shall be made of brick masonry with smooth cement mortar finish with suitable removable covers (i.e. precasted slabs or chequered plates). The dimensions of the trenches shall be determined depending upon the maximum number of cables that is expected to be accommodated and can be conveniently laid. Cables shall be arranged in tier formation in trenches and if necessary, cables may be fixed with clamps. Suitable clamps, hooks and saddles shall be used for securing the cables in position. Spacing between the cables shall not be less than 15 cm centre to centre. Wherever specified, trenches shall be filled with fine sand and covered with RCC or steel chequered trench covers.

Cable on Trays/Racks

Cable shall be laid on cable trays/racks wherever specified. Cable racks/trays shall be of ladder, trough or channel design suitable for the purpose. The nominal depth of the trays/racks shall be 150 mm.The width of the trays shall be made of steel or aluminium. The trays/racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware, entire steel trays/ racks shall be hot dip galvanized including widths & accessories. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of aluminium strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with the following requirements:

The tray shall have suitable strength and rigidity to provide adequate support for all contained cables.

It shall not present sharp edges, burrs or projections injurious to the insulation of wiring/cables.

If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion-resistant material.

It shall have side rails or equivalent structural members.

It shall include fittings or other suitable means for changes in direction and elevation of runs.

INSTALLATION

Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.

Each run of the cable tray shall be completed before the installation of cables.

In portions where additional protection is required, non combustible covers/ enclosures shall be used.

Cable trays shall be exposed and accessible.

Where cables of different system are installed on the same cable tray, non combustible, solid barriers shall be used for segregating the cables.

Cable trays shall be grounded by two nos, earth continuity wires. Cable trays shall not be used as equipment grounding conductors.

At no place the cable tray/ rack/ ladder running horizontally should rest on any building partition like Brickwall, RCC beams etc. but instead proper MS supports/ hangers to be provided at minimum of 1500 mm intervals and at every Turning Angles.

Jointing and termination's

Cable jointing shall be done as per the recommendations of the cable manufacturer. All jointing work shall be done only by qualified/licensed cable jointer.

All jointing pits shall be of sufficient dimensions as to allow easy and comfortable working.

Jointing materials and accessories like conductor, ferrules, solder, flex, insulating and protective tapes, filling compound, jointing box etc. of right quality and correct sizes, confirming to relevant Indian Standards.

Each termination's shall be carried out using brass compression glands and cable sockets. Hydraulic crimping tool hall be used for making the end termination's. Cable gland shall be bonded to the earth by using suitable size copper wire/tape.

HT CABLES:

GENERAL :

The cables shall be supplied, inspected, laid, tested and commissioned in accordance with Drawings. A specification, Indian Standard Specifications as per latest IS and cable manufacturer's instructions. The cables shall be of reputed make.

The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed. The installation of cables shall be done by an approved, qualified and experienced person in this trade.

MATERIAL :

The H.V. cables shall be 11KV, aluminium conductor CROSS LINKED POLYETHYLENE steel tape armoured cable laid underground and or in masonry trenches as shown on Drawings. The conductor shall be made of Electrical purity aluminium wires and stranded together and compacted. The cable shall be of 3 Core type. The insulation shall be of high quality cross linked polyethylene applied by extrusion process. Both conductor and the insulator are provided with shielding made of Semi Conducting compound. Armouring is applied over inner sheath and shall be of flat steel strips.The outer sheath shall be of heat resisting tropodur (PVC) compound. This shall be of black colour.

INSPECTION :

All cables shall be inspected upon receipt at site and checked for any damage during transit.

JOINTS IN CABLES :

The contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoidance of jointing cable.This apportioning shall be got approved by the Owner/Consultant before the cables are cut to lengths. Where joints are unavoidable, the location of such joints shall be got approved by the EIC.

JOINTING BOXES FOR CABLES:

Cable joint boxes shall be of appropriate size, suitable for aluminium conductor XLPE insulated cables of 11000 volts ratings, and shall be manufactured by CCI & Indian Cable Corporation or approved equal.

JOINTING CABLES:

All cable joints shall be made in suitable, approved cable joint boxes. Jointing of cables in the joint boxes and the filling in of compound shall be done in accordance with the best practice in trade, in accordance with manufacturer's instructions and in an approved manner. All straight T-joints shall be done in epoxy mould boxes with TROPOLIN/M-SEAL epoxy resin or approved equal. All jointing accessories shall also be manufactured by Indian Cable Corporation/CCI or approved equal. All terminal ends of conductors shall be heavily soldered upto atleast 50mm length.

All cables shall be jointed color to color and tested for continuity and insulation resistance before jointing commences. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection for the weather shall be arranged. Joints shall be made by means of suitable solder for conductors, the conductors being firmly butted into the connections or thimbles or ferrules and the whole soldered with proper solder and soldering flux or resin. The conductors shall be efficiently insulated with high voltage insulating tape and use of spreaders of approved size and pattern. The joints shall be completely filled with epoxy compound being topped as necessary to ensure that the box is properly filled.

CABLE TERMINATIONS:

Cable termination shall be done in terminal cable box using cable glands and the cable ends sealed with sealing compound. The cable boxes of transformers shall be filled with bituminous compound manufactured by CCI or approved equal.

BONDING OF CABLES:

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armoured clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that in the event of ground movement no undue stress is passed into the cable conductors.

LAYING OF CABLES:

H.V.cables shall be laid either buried directly underground or in Masonry/Concrete trenches. The cable buried underground shall be at minimum depth of 1.2 mtr. from the ground level. Sand cushion of not less than 80mm shall be provided both above and below the cable with a protective concrete slab on the top of the sand layer. The cable trench shall be back filled and compacted.

PROTECTION OF CABLES:

The cable shall be protected by placing precast reinforced 50mm, thick (1:2:4) concrete slabs 200mm wide on the top layer of sand for the length of the cable. Where more than one cable is running in the same trench, the concrete blocks shall cover all the cables and shall project minimum 80mm on either side of the cables.

Cables under road crossings and any surfaces subjected to heavy traffic shall be protected by running them through hume pipes of suitable size.

EXCAVATIONS AND BACK FILL:

All excavations and back fill including timbering, shorting and pumping required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layers not exceeding 150 mm. Each layer shall be properly rammed and consolidated before laying the next layer. The contractor shall restore all surfaces, roadways, sidewalks curbs, walls or other works cut by excavation to their original condition, satisfactory to the EIC.

MARKERS AND WARNING PLATES:

Approved C.I. cable markers shall be provided along the route of the cable at every 30 M Distance and at both ends of road crossing, indicating H.V. cables. Special C.I. markers shall be provided at all buried cable joints indicating Electrical cable joint.

TESTING OF CABLES:

Prior to burying cables, following tests shall be carried out:

Insulation between phases and between phase and earth for each length of cables, before and after jointing.

For H.V. cables, high voltage test by applying 17.5KV DC voltage for 15 minutes for each core and earth.

On completion of cable laying work, the following tests shall be conducted in the presence of the EIC.

Insulation Resistance Test (sectional and overall)

Continuity resistance test.

Sheathing continuity test.

Earth test.

All tests shall be carried out in accordance with relevant Indian standard code of practice and Electricity Rules. The contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests.

LOW VOLTAG, INTERNAL & EXTERNAL ELECTRICAL SYETEM:

CONDUITING AND WIRING:-

3.1.1 CONDUITING

Conduiting shall be carried out in MS Conduit. Conduiting shall be carried out as specified in point wiring head.

3.1.2 OUTLETS

All outlets shall be provided with modular range of cover plate, box and coaxial outlet. Cover plate shall match in shape & finish with other light and power accessories.

3.1.3 JUNCTION BOX

Suitable size of metallic junction box shall be provided for termination of conduit. Box shall be made of 1.6mm thick MS sheet and shall be treated before painting. Front of the junction box shall be provided with 3mm thick phenolic laminated sheet cover.

3.1.4 COAXIAL CABLES

The coaxial cable shall be of wideband type (RG-11 for Riser & RG-6 for distribution)

3.1.5 TAP OFF

These shall be of ultra wide bandwidth and of hybrid type. These shall have a flat frequency response over the entire operating range. These shall have a aluminium cast housing for high frequency radiation resistance.

The Tap offs shall be in one way, two way and four way configurations.

3.1.6 SPLITTERS

These shall be of ultra wide band width and of hybrid type. These shall have a flat frequency response over the entire operating range. These shall have a aluminium cast housing for high frequency radiation resistance.

The splitters shall be in 2 way, 3 way & 4 way configurations

3.2 INTERNAL & EXTERNAL ELECTRICAL SYSTEM

The work will be carried out in recessed PVC conduit wiring system in accordance of CPWD General Specifications for Electrical Works Part-I (Internal)-2013 and Part-II (External)-1994 with amendments up to the date of opening of bids and the governing specifications, which are mandatory including makes for some of the important materials to be used in the work. In case of ambiguity between the two, the specifications shall prevail.

TRANSFORMER (DRY TYPE)

4.1 SCOPE:

This standard specification covers the general requirements for the design, manufacturer, factory test, supply, loading, transportation, unloading at storage & testing of Cast Resin Dry Type Transformers suitable for indoor (basement) installation (having general requirements listed in following paragraphs). This specification is accompanied by the transformer data sheet.

4.2 Generally the transformer shall conform to IS:2026 and unless otherwise stated following standards shall be applicable and latest amended upto date.

i) IS: 1180

ii) IS: 3839

iii) IS: 6600

iv) IS: 335

v) IS: 1271

vi) IS: 2099

vii) IS: 3639

viii) IS: 2147

ix) IS: 3202

x) IS: 2705

xi) IS: 10028 (Part II & III): installation & maintenance of Transformer

4.3 Constructional Details:

4.3.1 The transformer shall be Cast ResinDry Type, AN cooled suitable for indoor (basement) installations. This shall be provided with welded sheet steel, free-standing enclosure with expanded metal screens of suitable size or louvers backed by wire-mesh. Transformer and upper body shall be suitably reinforced to prevent distortion during handling. Base channels shall be provided with skids and pulling eyes to facilitate handling.

4.3.2 All the fasteners and bolts shall be hot dip galvanized or zinc passivated.

4.3.3 The transformer shall be double wound core type with cold rolled grain oriented silicon steel laminations perfectly insulated and clamped to minimize vibrations and noise. Core fastening bolts shall be insulated to reduce losses and avoid hot spots. All parts of the magnetic circuit shall be effectively connected to earth system.

4.3.4 The winding shall be copper and shall be designed for full load current to withstand the thermal and electromagnetic stresses arising due to maximum fault level. The current carrying winding joints shall be electrically brazed.

4.3.5 The winding shall be provided with Class-"F" & above.

4.3.6 The transformer shall be designed with particular regards to suppression of harmonic voltages.

4.4 Terminals & Marshaling Box:

4.4.1 Winding shall be brought out and terminating on outdoor bushings, cable boxes or bus duct chamber which will be located as specified on data sheet.

4.4.2 Cable boxes shall be supplied with cable lugs and glands. H.T. cable box shall be suitably dimensioned to accept terminations of XLPE cable (11KV) 3C x 240 Sq mm.

4.4.3 The H.V./L.V. terminal boxes shall be located on the side respectively and at right angle or opposite to each other as specified in the data sheet. Suitable bus duct chamber shall be provided for 1600A 4 Pole Sandwich Type Aluminum Bus Duct.

4.4.4 Cable lugs shall be non-soldering, crimped type.

4.4.5 Terminal chamber for cable termination shall have a gasketted cover plate bolted to it. A separate cover plate shall be provided to facilitate the connection and inspection. Phase sequence of bus bar shall be as specified in Data Sheet.

4.4.6 Marshaling box shall be weather-tight. All protective devices and neutral CTs shall be wired by means of PVC insulated armoured cables upto marshaling box. Terminals shall be Elmex type or approved equal.

4.4.7 Provision of bus duct termination on secondary side to be made and accordingly secondary winding shall be brought to the terminal chamber.

4.5 Testing:

Purchaser's representative shall be given free access in the works one time inspection and progress reporting. The following routine and type tests shall be performed on the transformers as per IS:2026 or amendment upto date in the presence of purchaser's representative and certified test reports submitted. About three week's notice shall be given to the purchaser to witness the tests at the vendor's works.

4.5.1 Routine Tests:

The routine tests, including but not limited to the following shall be performed on each of the transformers, as per the relevant standards.

i. Measurement of winding resistance.

ii. Measurement of voltage ratio and check of voltage vector relationship.

iii. Measurement of impedance voltage/short circuit impedance and load loss.

4.5.2 Type Tests :

The transformer manufacturer should have tested 'Dry Type' transformer of rating 1000 KVA or above for 'Dynamic Short Circuit' at Independent Govt. Test Laboratory within last 2 years'.

4.5.3 Site Test:

The site test shall be carried out by the manufacturer/ contractor in the presence of the consultant/ Project In-charge as per the manufacturer's recommendations/ standards.

4.6 Accessories:

Accessories as specified in the attached Data Sheet shall be included in the scope of supply. The tapping and control gears shall be provided on the H.V. side. Tap changer shall be off-circuit type as specified in Data Sheet. The tap charging equipment shall be suitable for carrying the fault current.

Earthing Terminals

Two earth terminals of adequate mechanical and electrical capacity shall be provided. One separate earthing terminal shall also be provided on each separate radiator banks.

Winding Temperature Indicator (WTI)

Shall comprise of :

Temperature sensing element

Image coil

Bushing or turret mounted C.T.

iv. Local indicating instrument with electrically independent trip/alarm contact brought out to separate terminals.

4.7 Painting:

All metal parts shall be thoroughly cleaned to remove rust, scale, grease etc. and painted with two coats of approved color shade over one coat of rust resisting primer. The paint shall not scale-off, crinkle or removed due to normal handling.

All metal surfaces not accessible for painting shall be made of corrosion resistant material.

4.8 Rating Plate Details:

Each transformer shall be provided with a rating plate giving the details as per IS:11171 or latest amendment upto date. The marking shall be indelible and the rating plate shall be located on the front side.

Exact value of transformer % impedance, as determined by tests shall be marked on it and also on the final submission of nameplate.

4.9 Drawing & Documents:

i. All drawings and documents shall be submitted as per the requirements specified in vendor data.

ii. Complete technical particulars as per Appendix-B of IS:11171 latest amendment upto date as applicable to Dry Type Transformers shall be furnished with the quotation.

iii. Make and type of various accessories and protective devices shall be furnished with the quotation.

4.10 Guarantee:

The transformer shall be guaranteed for trouble-free service for the period of 12 months from the date of taking over till completion of defect liability period. Any defects discovered during this period shall be rectified free of charge.

4.11 Information Required with Bids:

4.11.1 Clause-wise deviations to this specification. If the same are not furnished it will be assumed that the offered equipment meet the enquiry specifications in to.

4.11.2 Information as sought in clause 10.0

4.11.3 GA drawing of each rating covered in BOQ.

4.11.4 True un-priced copy of the priced bid.

TRANSFORMER DATA SHEET (750 KVA)

1.0	GENERAL		
1.1	Application	:	Distribution Transformer Dual Ratio
1.2	Quantity Required	:	1 No.
1.3	Installation	:	Indoor -Basement (Solid Ground)
2.0	RATINGS		
2.1	Rating KVA	:	750
2.2	Number of phases & Frequency	:	3 PHASE, 50Hz
2.3	Type of cooling	:	AN
2.4	No Load Voltage		
2.4.1	HV	:	11000 V
2.4.2	LV	:	415 V
2.5	Vector Group	:	Dyn11

2.6	Percentage Impedance	:	5.5 %
3.0	VOLTAGE	:	
3.1	Nominal System Voltage		
3.1.1	HV	:	11000 V
3.1.2	LV	:	415 V
3.2	Highest System Voltage		
3.2.1	HV	:	11000 V
3.2.2	LV	:	415 V
4.0	TAPCHANGING GEAR:		
4.1	Taps ON/OFF Load	:	OFF Load Tap Changer
4.2	Tapping on windings HV/LV	:	HV
4.3	Total tapping range	:	+7.5% to –7.5%
4.4	Steps	:	2.5%
5.0	TEMPERATURE RISE		
5.1	Ref. Ambient OC:	45OC	
5.2	Winding by Resistance OC	:	90OC
6.0	INSULATION WITHSTAND		
6.1	Impulse (1.2x50 micro second wave)	:	12 KV
7.0	NEUTRAL EARTHING		
7.1	System Neutral		
	Effectively Earthed/Resonant Non effectively		
	Earthed/Isolated :	Effectively Earthed	
7.2	Neutral :	Effectively Earthed	
8.0	ACCESSORIES:		
8.1	Winding Temperature Indicator	:	Yes
8.2	Wheels Plain/Flanged / bidirectional /		
	Unidirectional	:	Plain, Bidirectional
9.0	TERMINATION ARRANGEMENT		
9.1	H.V. Side (Cable Box)	:	Cable box and disconnecting chamber suitable for 3C x 240 Sq. mm 11 KV XLPE cable with top entry.
9.2	L.V. Side (Bus duct)	:	Bus duct Chamber for 1250A bus duct
10.0	Paint Shade	:	RAL 7032 Siemens Grey.

11.0 Limit Switch for Interlocking Access to tapping links.

12.0 Enclosure : IP: 33 or suitable for Indoor use.

DATA TO BE FURNISHED

1.0 TRANSFORMER :

1.1 Name of Manufacturer :

1.2 Standards followed in design manufacture and testing :

1.3 Continuous maximum rating in KVA :

1.4 Transformer no-load voltage

1.4.1 High voltage :

1.4.2 Low voltage :

1.5 Vector group reference :

1.6 Terminal Arrangement

1.6.1 H.V. Side :

1.6.2 L.V. Side :

1.7 One-minute dry power frequency test withstand voltage in KV :

1.7.1 High voltage :

1.7.2 Low voltage :

1.8 Impulse test withstand voltage with 1.2 x 50 microseconds wave in KV :

1.9 Type of tap changer :

1.9.1 No. of plus taps :

1.9.2 No. of minus taps :

1.10 Iron losses in KW at rated voltage and frequency :

1.11 Copper losses in KW at rated full load current and frequency at 75 OC :

1.12 Reactance voltage with guaranteed tolerance in percent at rated full load current and

frequency 75 OC :

1.13 Impedance voltage with guaranteed tolerance in percent at rated full load current and frequency at 75 OC :

1.14 Regulation in percent of no-load voltage at full load current at 75 degree C and with power factors of :

1.14.1 Unity :

1.14.2 0.8 lagging :

1.15 Efficiency in percent at 75 OC and unity power factor for :

1.15.1 100 percent load :

1.15.2 75 percent load :

1.15.3 50 percent load :

1.16 No-load current in amperes at rated voltage and frequency :

1.17 Inrush magnetizing current in percent of normal full load current. :

1.18 Details of winding insulation :

1.18.1 Class of insulation materials :

1.18.2 Turns insulation high voltage in mega ohm :

1.18.3 Turns insulation low voltage in mega ohms :

1.18.4 Insulation core to low voltage in mega ohms :

1.18.5 Insulation high voltage to low voltage in mega ohms :

1.19 Details of 415 V neutral current transformer :

1.19.1 Name of manufacturer :

1.19.2 Current ratio :

1.19.3 VA capacity :

1.19.4 Accuracy & performance characteristics :

1.20 Weights

1.20.1 Core and windings in kg :

1.20.2 Complete transformer :

1.21 Overall Dimensions :

1.21.1 Length in mm :

1.21.2 Breadth in mm :

1.21.3 Height in mm :

2.0 TESTS:

2.1 List of tests proposed to be carried out at the factory :

2.2 List of tests proposed to be carried out at the site before commissioning :

INFORMATION TO BE FURNISHED BY THE VENDOR AFTER AWARD OF CONTRACT

1.0 Positive sequence impedance at maximum voltage tap.

2.0 Positive sequence impedance at minimum voltage tap.

3.0 Zero sequence impedance at principal tap.

4.0 Efficiency at 75OC winding temperature:

4.1 At full load

4.2 At 75% full load

4.3 At 50% full load

5.0 Maximum efficiency and load at which it occurs.

6.0 Regulation at full load at 75OC winding temperature at:

6.1 Unity power factor

6.2 0.85 power factor lag.

7.0 Resistance per phase of :

7.1 H.V. winding : Ohms

7.2 L.V. winding : Ohms

8.0 Conductor area (sq. cm) and current density (Amps/cm2)

8.1 HV winding

8.2 LV winding

9.0 Type of windings

9.1 HV

9.2 LV

10.0 Insulating materials for interturn insulation:

10.1 HV winding

10.2 LV winding

11.0 Insulating materials for winding insulation

12.0 Insulating materials

12.1 Winding and core

12.2 Laminations of the core.

13.0 Make, type, dial rise, number of contacts and contact ratings (current following items, if provided).

13.1 Dial type thermometer.

13.2 Winding temperature indicator.

14.0 Thermal with-stand capability under full short circuit conditions in terms of number of times of calculation of short circuit and corresponding anticipation percentage reduction in transformer life. Relevant calculations shall be submitted.

15.0 DRAWINGS

The following drawings shall be submitted to Engineer-in-charge for approval in the stipulated time.

15.1 General outline drawings showing plan, front elevation, rear elevation, cable boxes / disconnecting chamber section views, location & dimensions of cable entries, terminals foundation floor fixing details and weights.

15.2 Bushings: Plan, elevation terminals details, mounting details make and type number, current and voltage rating, creepage distances and principal characteristics.

15.3 Rating and diagram plate

15.4 Marshalling box terminal connections, wiring diagram

16.0 TEST REPORTS

Test results shall be corrected to a reference temperature of 75 OC.

16.1 Two copies of test results shall be submitted for the Owner's/Consultants approval before dispatch of transformer.

16.2 Additional bound copies, as required by the EIC, of complete test results including all tests on transformer, bushing, current transformer (if provided), shall be furnished with the transformer.

11 KV METERING AND 11 KV VCB PANEL

H.T. METERING PANEL (INDOOR TYPE):

GENERAL

H.T. Metering Panel shall be made as per regulation of Local Electricity Supply Authority.

CODES AND STANDARDS

The 11 H.T. Metering Panel shall comply with the following standards as amended up to date.

IS: 2544 : Bus Bar Supports

IS: 2705 / IEC – 185 : Current Transformer

IS: 3516 / IEC – 186 : Potential Transformer

SUBMITTALS

SHOP DRAWING AND TECHNICAL DATA

The Tenderer shall furnish relevant technical data on H.T. Metering Panel and associated equipment along with the offer.

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.

b) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.

c) All drawings and data shall be in English.

TYPE AND CONSTRUCTION

The metal clad panel shall be made out of 2.0 mm thick CRCA sheet steel. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphating process and shall then be given powder coating (Electrostatic) paint of manufacturer's standard shade.

a. C.T. & P.T. Compartment

b. Energy Meter Compartment

c. Cable Termination Compartment

The compartments shall be dust & vermin proof and safe to touch. The H.T. Metering Panel shall be suitable for cable termination from bottom only. The Panel shall be supplied with all equipment mentioned in BOQ and as per regulation of Local Electricity Supply Authority.

11 KV VCB PANEL

SCOPE

This specification covers design, engineering, manufacture, shop testing, delivery at site, erection, testing and commissioning of type tested 12 KV, 3 phase, metal clad indoor, Horizontal draw out type, Vacuum Circuit Breaker (VCB) Switchboard with all accessories and protective devices mounted and wired up.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of the Switch Board offered shall comply with all currently/latest applicable standards (including amendments thereto), regulations and safety codes in the locality where the equipments will be installed. Nothing in this specification shall be construed to relieve the Supplier of his responsibility. Where no standards are available, the supply items shall be of good quality and workmanship and backed by test results. Other National Standards are acceptable if they are established to be equivalent to or superior to the listed standards.

	Standards	
	IEC: 62271 - 1	High-voltage switchgear and control gear - Common specifications.
	IEC: 62271 - 100	High-voltage switchgear and control gear - Alternating current circuit-breakers.
	IEC: 62271 - 200	High-voltage switchgear and control gear - AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.
	IEC: 600441-1	Current Transformers
	IEC: 600441-2	Voltage Transformers
	IEC: 60529	Classification of degrees of protection provided by enclosures
	IEC: 60038	Standard Voltages
	IEC: 60255	Measuring relays and protection equipment - Part 24: Common format for transient data exchange (COMTRADE) for power systems.
	ANSI IEEE C 37/20	Switch gear assemblies including metal enclosed bus.

CIRCUIT BREAKER

The circuit breaker shall be mounted on a withdrawable truck which shall roll out horizontally from service position to isolated position with ease and it shall also be possible to take out the breaker truck from cubicle smoothly on to the floor without use of any separate handling equipment. It is preferable to provide three point guide for withdrawal and insertion of truck into the cubicle with ball bearing arrangement on the top of the truck. Circuit breaker shall be of vacuum only and the truck shall have distinct 'SERVICE' and 'TEST' position. Isolated position by defeating the interlock shall also be inside the cubicle so that the front door of breaker compartment can be closed even in breaker isolated position. Special more than three point hinged locking arrangement shall be provided to prevent opening of door in the event of internal arc in breaker compartment. Isolation shall be horizontal.

All the three interrupters of individual phases shall be mounted on a common phase segregated epoxy body mounted on a truck for better insulation and avoidance of non-simultaneity of poles. Circuit breaker shall be vacuum type only. Bidders should be

the manufacturer of vacuum interrupter as pre requisite for qualifying.Interrupter mounted on the conventional individual insulators will not be accepted. No separate fiber glass sheet barrier to be used.

It shall be operated through a common motor wound spring charged mechanism with electrical release coil for closing and shunt trip coil for tripping. Operating mechanism must have manual charging, closing and tripping facility with the provision locking facility in push to close & push to trip mechanical push button.

The mechanism shall be such that motor will automatically recharge the mechanism springs after a closing operation enabling breaker to perform OCO operation. The charging time of motor shall be less than 15 secs making it suitable for rapid auto reclosing duty. Emergency mechanical push to trip button shall be provided for emergency manual tripping with front door closed. All the 'MS' components of circuit breaker mechanism shall be treated with zinc platting with olive green passivation for longer life even in adverse climatic condition. Yellow passivation shall not be acceptable. All mechanism springs shall be powder coated. Plating on mechanism spring is not acceptable. The normal current rating of circuit breaker shall be in panel rating without fan.

There shall be minimum 4 NO and 4NC contacts in breaker auxiliary switch. Incase of Additional contacts the same can be multiplied through latched type contactors. Auxiliary plug and socket shall be of minimum 24 pin plug type and shall have scrapping earth feature. Auxiliary contacts shall be suitable for continuous thermal current rating of 10A.

INTERLOCKS

Circuit breaker can be inserted only in open position. Likewise circuit breaker in closed position cannot be withdrawn. Attempt to draw out closed breaker shall not trip the breaker.

The circuit breaker shall operate only in one of the three defined positions i.e. service, test and isolated. The breaker shall not close in any of the intermediate positions.

The circuit breaker cannot be inserted into service position till auxiliary contacts are made. Similarly interlock prevent auxiliary contacts from being disconnected, if circuit breaker is in service position.

It will not be possible to rack out the withdrawable part from Service to Test position when the switching device is switched ON. Similarly, it will not be possible to rack in the withdrawable part from Test to Service position, if the switching device is switched ON.

Any attempt to rack out withdrawable part from Service to Test position will not result in switching OFF of the Circuit Breaker instead the Service position will be locked till switching device is 'ON'.

It will not be possible to rack in or rack out withdrawable truck when the front high voltage door is open. However, a suitable defeat interlock mechanism is provided for emergency purpose.

It will not be possible to rack in the withdrawable truck from test to service position when the low voltage control plug is not in position and locked on the truck itself.

It will not be possible to close the door if the low voltage control plug is not engaged.

BUSBARS

Bus bar material shall be Electrolytic Copper.

All bus bars shall be insulated with heat shrinkable PVC sleeves.Joints shall be insulated with shrouds in busbar chamber and interphase barrier shall be provided in cable chamber.

Phase identification shall be made at the end by colored tape.

Bus bars shall be mounted on integral seal off bushings while passing from one compartment to another except busbar compartment.

Busbar shall run throughout the switchgear without interruption so in case of any arc, arc shall travel and cause minimum damage to the switchgear.

Temperature Rise of busbar along with other parts of switchgear shall be governed by IEC 60694, Table III.

CUBICLE CONSTRUCTION

The switchgear panel shall be of sheet steel construction with ALUZINC not less than 2.5mm thickness for load bearing section and not less than 2 mm thickness for non-load bearing and shall totally dust and vermin proof. The panels shall be rigid without using any external bracings. The switchboard panels should comply with relevant IS/IEC and revision thereof and shall be designed for easy operation maintenance and further extension. Bus bar, metering circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. All instruments shall be non-draw out type and safe guard in every respect from damages and provided with mechanical indicator of connection and disconnection position. The switchgear shall be completed with all necessary wiring fuses, auxiliary contacts terminal boards etc.

Width of cubicle is 600mm up to 1250A and 800 mm above 1250A.

Joints for All front door shall be provided with neoprene or cross linked poly ethylene gaskets self adhesive type

All the high voltage compartments must have pressure discharge flap for the exit of gas due to internal arc to insure operator safety. All the HV compartment design i.e. Busbar compartment, VCB compartment and Cable compartment should ensure conformity to IEC 62271-200 and must be type tested individually for Internal Arc Test for AFLR 18.37kA for 100ms. The switchgear panels shall be suitable for loss of service continuity LSC 2B. Safety shutters complying with IEC-62271-200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position.

Safety shutters shall be metallic and shall be provided to cover up the fixed High voltage contacts on bus bar and cable sides when the truck is moved to Test/ isolated position. The shutters shall move automatically, through a Linkage with the movement of the truck and shall be of gravity fall type only. It shall be possible to padlock shutters individually.

Switch gear cubicle shall have seal off bushing arrangement between the circuit breaker compartment and bus bar/ C.T. cum cable compartment, i.e. the fixed isolating contacts shall be embedded in epoxy cast bushing so the these act as seal off bushing to prevent transfer of arc from one compartment to the other in the event of internal arc within the cubicle & must be tested for internal arc in all three HV compartments as per new IEC 62271-200.

Louvers can be provided for higher normal current rating however, same shall be backed up by fine wire mesh.

Joints for All front door shall be provided with neoprene or cross linked poly ethylene gaskets self adhesive type. For Compressibility step type channel base shall be provided for easy compressibility. It shall be preferable to provide cross linked poly ethylene type. It shall be preferable to supply cubicle with gaskets between all metal to metal proper vermin proof. Minimum degree of protection shall be IP4X.

LOW VOLTAGE COMPARTMENT

Low voltage compartment shall be mounted at the front on the top of breaker compartment and shall also have hinged type of door.

All wiring shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover.

For current transformer terminal shall be disconnecting link type only.

The wire shall be of 1.1KV grade and suitable for 2KVrms for I minute power frequency high voltage.

CABLE COMPARTMENT

It shall be at the rear side with rear bolted box type back covers. There shall be an inspection window at the rear back cover enabling operator to have visual inspection without opening back cover in live condition.Viewing window at the rear side shall be of poly carbonate only and shall be tested for internal arc.

The gland plate of cable chamber shall be of minimum 3mm thickness MS sheet in two halves section with built in adjustable cable holding clamp. In case of single core cable it shall be supplied with non magnetic gland plate. Cable box shall accommodate 2-3Core 630 sq. mm. Cables or 6-1C cables.Addition rear extension box of minimum 500 mm depth shall be provided for cables more than the quantity mentioned above.

Sufficient headroom shall be provided for cable termination. The distance between gland plate and terminal shall be minimum 600mm.

Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side. Power cable entry shall be from rear bottom. Provision shall be available for entry of power cable or bus duct from rear bottom or rear top.

EARTHING

There shall be a continuous copper earth bus of size 50x6 sq. mm running at the bottom of the panel. Earth bus shall be robust and shall be capable of carrying full short circuit current for 1 second. Doors, covers and all non-current carrying metallic parts shall be earthed through flexible copper wires. This also includes instrument casing and cable armour which are also connected to the earth bus. Earth bus must be tested for 18.37KA for 1 sec

Separate earthing truck shall be provided for bus earthing and cable earthing. The earthing truck shall be so designed that it is impossible to earth a live. It shall be provided with capacitive voltage divider and complete with audio visual annunciation.

In addition to scrapping earth in auxiliary plug and socket proper arrangement should be made so that during engagement of the breaker in service condition earthing contacts is made first before isolating power contacts are engaged.

CURRENT AND POTENTIAL TRANSFORMER

Current transformers shall be double core window/bar primary for higher rating or wound primary for lower rating. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current for 1 second. Differential /REF CTs can be in one mould. Incase of numerical relays 10VA burden shall be sufficient. CT shall be of a minimum accuracy of class 0.5/5P10 and CT Secondary rating shall be 1A unless otherwise specified. Potential transformer shall be 3phase 3 limb type with 50VA per phase of class 0.5/3P accuracy and shall be mounted on incomer breaker truck. For bus connected P.T the same shall be mounted in a separate withdrawable truck in a separate vertical panel.

PROTECTION RELAYS

The Protective IDMT O/C, E/F relays should be of numerical type with the same Technical specification. The relay should have feature for storing fault data, should have site selectable CT secondary relay currents i.e -/5 Amps or -/1 Amps. Should have LED/LCD for each function element of a relay to enable to identify the type of fault condition. All the switch gears shall be provided with microprocessor based numerical protective relays designed to disconnect faulty circuit with speed and discrimination and shall confirm to latest revision of relevant standards regarding accuracy and other feature. Composite relay unit having O/C, E/F, O/V, U/V etc. shall be preferred. The numerical relays shall be communicable type and shall

communicate on MODBUS protocol. Use of communication protocol converter is not acceptable.Min 10 DI/DO has to be provided. Every Panel should have Arc Flash Protection in Cable and BusBar Chamber.

Protection of Various type of feeders as follows:

Incomer:1 No of SCADA Compatible Feeder Protection Relay 50/51(3 phase overcurrent), 50/51N (Earth overcurrent), 67P (3 phase directional overcurrent), 67N (Earth fault directional overcurrent), 51V(Voltage controlled overcurrent), 37 (3 phase undercurrent), 46 (Negative phase sequence overcurrent), 59N (Residual over voltage), 32 (Directional Power protection (Under/Over active/reactive power), 81U/O (Under/over frequency), 49 (Thermal overload), 79 (Autoreclose), 50BF (Circuit breaker failure detection), Cold load pick up, Inrush blocking. Relay will be on Modbus Protocol Master Trip Relay

Outgoing Transformer Feeder : 1No. of SCADA Comaptble Feeder Protection Relay 50/51(3 phaseovercurrent), 50/51N (Earth overcurrent), 67P(3 phase directional overcurrent), 67N (Earth fault directional overcurrent), 51V (Voltage controlled overcurrent), 37 (3 phase undercurrent), 46 (Negative phase sequence overcurrent), 59N (Residual over voltage), 32 (Directional Power protection (Under/Over active/reactive power), 81U/O (Under/over frequency), 49 (Thermal overload), 79 (Auto reclose), 50BF (Circuit breaker failure detection), Cold load pick up, Inrush blocking. Relay will be on Modbus Protocol

Master Trip Relay

Transformer Fault Alarm/Trip Aux. Relay. For Transformer Feeder only.

METERING

Ammeter & voltmeter selector switches shall be four position type. Ammeter selector switches shall have make before break feature to prevent open circuiting of CT secondary. Selector switch shall be suitable for semi flush mounting with only switch front plate and operating handle projecting out.

Multifunction meter: Digital type (Displaying A, V, PF, Hz, KVA, KW, KVAR, KWh, KVARh etc.) Class 0.5 with RS485 port for communication in Modbus protocol. Make : Schneider EM 6400 or equivalent shall be provided in all incomers and outgoing feeders

AUXILIARY/CONTROL WIRING

Control supply for closing and tripping shall be 220 or 110Volts D.C. through external battery source. 230 Volts single phase A.C. supply shall also be available for the operation of spring charging motor and cubicle space heater. Wattage of closing and tripping coils shall be within 250 watts. Aux supply shall be suitably distributed along with switchgear in loop in loop out fashion.

All Switchgear panels shall be supplied completely wired internally upto the terminal block ready to receive external cabling.

All the secondary wiring in the panel shall have high quality PVC insulation and the same shall have conductor size of not less than 1.5 mm2 of copper.

Colors of the secondary/auxiliary wiring should confirm to IS 375/1963 and latest amendment thereof if any. All wiring shall be neatly run and group of wiring shall be securely fixed by clips so that wiring can be checked without necessity of removing the clamps. Wiring between fixed and moving portion of the panel shall be run in flexible tubes and the same shall be so mounted to avoid any damage to them due to mechanical movements. Ferrules with number shall be provided on both end of the wiring.

All wires directly connected to trip the circuit breaker shall be distinguished by the addition of a red colored unlettered ferrule

PRE TREATMENT AND PAINTING

Switchgear front and rear covers shall be painted for aesthetic purposes and Paint shade shall be RAL 7032.

NAME PLATE AND DIAGRAM PLATES

All equipment shall have weather proof and non-corrosive metal plates fixed in suitable position with full particulars engraved thereon with white letters against black background.

The firm shall affix a name plate on each Switchgear panel having following information:

Manufacturer's name

Type of Panel.

CT Ratio.

Rated Voltage.

Rated Insulation Level

Rated Frequency

Rated Normal Current

Rated Short Circuit Breaking Current.

Order No. and Date

Year of supply.

TESTS

The design of circuit breaker shall be proven through all the routine and type tests in accordance with IS IEC 62271-200 and any amendment thereof. Photocopy of all the test reports must be enclosed with the tender. Type test report earlier than 5 years from the date of tender opening shall not be acceptable.

The Bidder shall submit the type test reports of following type tests for approval of the Purchaser

Short circuit duty test on circuit breaker, mounted inside the panel offered.

Short time withstand test – on circuit breaker, mount inside panel offered.

Power frequency withstand test on breaker and panel.

Lightning impulse withstand test on breaker and panel.

Temperature rise test on breaker and panel together.

Measurement of resistance of main circuit.

Mechanical endurance test on breaker. Mechanical operation test.

Internal arc current (IAC) test on individual compartments i.e. Busbar, VCB and cable compartment.

MEDIUM VOLTAGE PANELS:

GENERAL

Medium Voltage power control centers (generally termed as switchboard panels) shall be in sheet steel clad cubicle pattern, free floor standing type, totally enclosed, compartmentalized design having multi-tier arrangement of the incomers and feeders as per details given in the schedule of quantities. The panels shall be of extensible type with provision of bus bar extensions. All panels shall conform to the requirements of the latest addition of IS and shall be suitable for 415 V, 3 phase AC supply or 230 V single phase AC supply as required.

CONSTRUCTION

All switch board panels or power control centers of free standing type shall have a bus bar chamber at the top and the cable compartment at the bottom or as approved by the Developer/Consultants depending upon the specific requirements of the job. The space between the bus chamber and cable compartment shall be suitably compartmentalized to accommodate either air circuit breakers or molded case circuit breaker of various ratings. The cable terminations shall be carried out on the rear side of the panels for which adequate space and clamping arrangements shall be provided. Where panels have to be installed with very little access space at the rear, the cable terminations shall be carried out in suitable cable alleys provided on the front of the panel. All the live parts shall be properly shrouded with Bakelite barriers. All the equipment shall be accessible from the front. However, protection relays, KWH meters, etc. may be mounted on the rear side/front side. Arrangements and marking of bus bars, main connections and wiring shall be in accordance with latest IS code. The structure of the panel shall be robust and provided with adequate bracing's to withstand the operation of the equipment and stresses due to system short circuit. The panels shall be fabricated out of best quality heavy gauge sheet steel. The panel shall be machine pressed with punched openings for meters, indicating lamps etc.

DIMENSIONS

All power control centers shall have dimensions of not more than that given on the layout drawings. Panels arranged side by side shall have the same height and depth. The height of the panel should be limited to 2400 mm. All the operating levers, handles etc. of the highest unit shall not be at a height more than 1700 mm from F.F.L. For all incoming cables a removable gland plate will be provided in the panel and a minimum distance of 300 mm will be provided between the gland plate and the nearest terminal for proper dressing and termination of the cable. All the components of a module will be mounted on a component plate using the machine screws and taped holes (excepting the components mounted on the door). These component plates should be fixed with bolts for easy replacement. Standardization will be adopted while making these plates so that the component plates of the same size modules can be changed from one module to another. In case of panel of lengths more than 4 meters the fabrication of any single section will be limited to a maximum length of 4 meters for the purpose of shipping and shifting at the site. These sections will be assembled at the location of installation with the help of nuts and bolts. While making these sections consideration will be given to the place of sectionalization and select the location where the minimum electrical connections are transferred from one section to another. All the hardware used in the assembly will be electroplated for protection and neat appearance.

BUS BARS

The bus bars shall be suitable for 4 wire, 415 Volts, 50 Hz, system. The main bus bar shall be made of high conductivity electricity conductor grade electrolytic AL 91E Aluminum and shall be liberally sized. In case of copper bus bar it shall be electrically conductor grade electrolytic copper and at the time of joining of two copper buses tinning will be done on the copper strips ends to a length equal to the lap length of the joint plus one each. The bus bars shall have uniform cross section throughout. The bus bars shall be capable of carrying the rated current at 415 Volts continuously. The bus bar will run in a separate bus bar chamber using bus insulators made of non-deteriorating, vermin proof, non hygroscopic materials such as epoxy fiber, reinforced polyester or molding compound. The interval between the two insulators will be designed after considering:

Strength and safe load rating of the insulator,

The vibrating force generated during a fault,

A Factor of safety of 1.8

A set of insulators at both ends of the bus.

The size of the bus bar calculations must be approved by the consultants. The bus bars shall be designed to withstand a temperature rise of 45 degree above the ambient. To limit the temperature rise in the bus bar chamber a set of louvers can be provided at strategically places considering the air circulation. The louvers provided will have a brass wire mesh covering from inside with more than 100 openings per sq. inch. The overall temperature of bus bar shall not exceed 85°C in any case. A current density of 1.0 Amps/Sq. mm shall not be exceeded for Aluminum bus bars.

All the bus bars shall be insulated with PVC heat shrinking sleeves suitably throughout (except at joints) the length. The electro galvanized high tensile steel nuts, bolts, plain or spring washers of suitable size will be used in connecting the various section of the bus bar. A minimum of 1.6 times the width of bus bar will be the lapping length of each joint.

EARTHING

The panels shall be provided with an aluminum or copper earth bus of suitable size running throughout the length of the switchboard. Suitable earthling eyes/bolts shall be provided on the main earthing bus to connect the same to the earth grid at the site. Sufficient number of star washers shall be provided at the joints to achieve earth continuity between the panels and the sheet metal parts.

INTERLOCKING

The panels shall be provided with the following interlocking arrangement.

The door of the switch-fuse compartments is so interlocked with the switch drive or handle that the door can be opened only if the switch is in `OFF' position. De-interlocking arrangement shall also be provided for occasional inspection.

It shall not be possible for the breaker to be withdrawn when in `ON' position.

It shall not be possible for the breakers to be switched on unless it is either in fully inserted positions or for testing purposes in fully isolated position.

The breaker shall be capable of being raked in to `testing' `isolated' and `maintenance' positions and kept locked in any of these position.

A safety latch to ensure that the movement of the breaker as it is withdrawn, is checked before it is completely out of the cubicle shall be provided.

PROTECTION & INSTRUMENTATION

Protection and instrumentation shall be as per standard specifications.

CONTROL WIRING

The control wiring of all the panels will be done with PVC single core flexible copper wires of cross section 1.5 sq. mm and 2.5 sq. mm. All the wiring involving current transformers or circuits with currents of more than 5 Amps will be wired with 2.5 sq. mm cross section wire and the others with 1.5 sq. mm. Similarly all the interconnecting between the incoming bus and the outgoing of 100 Amps and above rating shall be done by insulated copper strips of suitable sizes and equipment below 100 Amps rating shall be wired with insulated copper conductors. All of the control wiring will be done by properly dressing all the wires in a laminar manner either in a PVC duct of liberal size or bunched together by PVC strapping tapes at a distance not exceeding 150 mm. Each wire will terminate with a copper ferule crimped to the wire. The PVC ferules will be used to identify each wire of the circuit and the same number will be marked on the drawing for the corresponding wire. Only one outgoing wire will be connected to one connector. When the control wiring is crossing from fixed parts to moving parts such as door etc. the wire will be run in PVC sleeve of suitable size and the same will be mechanically clamped at both the ends i.e. one end of the fixed part and the other on the moving part. Under no circumstances the wiring should be under any kind of stress for which sufficient length of control wiring in the PVC sleeve should be provided. All the potential circuits shall be protected by fuses mounted near the tap off point from the main connections.

SURFACE TREATMENT

The each part of the fabricated panel will be subjected to seven tank treatment and all sheet metal accessories and components of power control centers and switchboard panels shall be thoroughly cleaned, degreased, de-rusted and hot dip phosphatized before red oxide primer is applied. The panel shall be stove enameled gray shade finish and the Interior surfaces of the panel shall be painted to an off-white shade.

ENCLOSURE

The panel enclosure shall be totally dust and vermin proof and shall be suitable for indoor installation. All the cubical will be adopted with front located, outward openings, lockable doors having hidden hinges and a bolted back cover both using no detoriorating neoprene rubber gasket. Enclosure design shall be in accordance with degree of protection IP 54 as per latest IS code. All the nut bolts handles, meters, knobs etc. appearing from outside of the panel should be located in symmetry so as to give a neat appearance.

NAME PLATE

The panel as well as the feeder compartment doors shall be provided with name plate giving the switchboard/feeder descriptions as indicated on the drawings. The above shall be mounted in metal holder with a clear plastic sheet on inside surface of the front door.

TESTING

The power control centers shall be tested at factory after assembling of all components and completion of all interconnections and wiring. Tests shall be conducted in accordance with the requirements of BS: 3659.

Insulation Test

Insulation of the main circuit, i.e. the insulation resistance of each pole to the earth and that between the poles shall be measured.

Insulation resistance to earth of all secondary wiring should be tested with 1000 Volt magger. Insulation test shall be carried out both before and after high Voltage test. High Voltage Test A high Voltage test with 2.5 KV for one minute shall be applied between the poles and earth. Test shall be carried out on each pole in turn with the remaining poles earthed, all units raked in position and the breakers closed. Original test certificate shall be submitted along with panel.

STORING, ERECTION AND COMMISSIONING

The panels shall be stored in a well ventilated, dry place, with suitable polythene covers shall be provided for necessary protection against moisture.

Erection

Switch boards shall be installed on suitable foundation. Foundation shall be as per the dimensions supplied by the panel manufacturer. The foundation shall be flat and levelled. Suitable grouting holes shall be provided in the foundation. Suitable MS base channel shall be embedded in foundation on which the panel can be directly installed. The switch boards shall be properly aligned and bolted to the foundation by at least four bolts. Cables shall be terminated on the bottom plate or top plate as the case may be, by using high quality brass compression glands. The individual cables shall then be led through the panel to the required feeder compartments for necessary terminations. The cables shall be clamped to the supporting arrangement. The switchboard earth bus shall be connected to the local earth grid.

Pre-commission Tests

Panels shall be commissioned only after the successful completion of the following tests.

The tests shall be carried in the presence of Developer/Consultant or their representatives.

All main and auxiliary bus bar connections shall be checked and tightened.

All wiring termination and bus bar joints shall be checked and tightened.

Wiring shall be checked to ensure that it is according to the drawing.

All wiring shall be tested for insulation resistance by a 1000 Volts magger.

Phase rotation tests shall be conducted

Suitable injection tests shall be applied to all the measuring instruments to establish the correctness and accuracy of calibration and working order.

All relays and protective devices shall be tested for correctness of settings and operation by introducing a current generator and an Ammeter in the circuit.

METERING, INSTRUMENTATION AND PROTECTION.

Ratings, type and quantity of meters, instruments and protective devices shall be as per Bill of Quantities.

Current Transformers

CTs shall confirm to latest IS codes in all respects. All CTs used for medium Voltage application shall be rated for 1 kV. CTs shall have rated primary current, rated burden and class of accuracy as specified in schedule of quantities/drawings. Rated secondary current shall be 5A unless otherwise stated. Minimum acceptable class for measurement shall be 0.5 to 1 and for protection class 10. CTs shall be capable of withstanding magnetic and thermal stresses due to short circuit faults. Terminals of CTs shall be paired permanently for easy identification of poles. CTs shall be provided with earthing terminals for earthing chassis, frame work and fixed part of metal casing (if any). Each CT shall be provided with rating plate indicating:

• Name and make

• Serial number

• Transformation ratio

• Rated burden

• Rated Voltage

• Accuracy class

CTs shall be mounded such that they are easily accessible for inspection, maintenance and replacement. Wiring for CT shall be with copper conductor PVC insulated wires with proper termination works and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

Potential Transformer

PTs shall confirm to latest amendment upto to date IS Codes.

Measuring Instruments

Direct reading electrical instruments shall conform to latest IS codes in all respects. Accuracy of direct reading shall be 1.0 of Voltmeter and 1.5 for Ammeters. Other instruments shall have accuracy of 1.5. Meters shall be suitable for continuous operation between -100C and +5000C. Meters shall be flush mounting and shall be enclosed in dust tight housing. The housing shall be of steel or phenolic mould. Design and manufacture of meters shall ensure prevention of fogging of instrument glass. Pointer shall be black in color and shall have Zero position adjustment device operable from outside. Direction of deflection shall be from left to right. Selector switches shall be provided for Ammeters and Volt meters used in three phase system.

AIR CIRCUIT BREAKER (ACB)

GENERAL:

ACB shall comply with standards IS/IEC 60947-1 & 2.

ACB shall have a rated operational voltage of 415V AC, rated insulation voltage of 1000 volts AC, rated impulse voltage of 12kV.

ACB shall be of 3pole or 4pole (as per BOQ), air break, molded case design for longer life along with less maintenance requirement.

All ACBs shall preferably be of single frame size up to 3200A to optimize requirement for spares management.

ACB shall have a Ready to close mechanism preferably having a ready to close mechanical indication on front of ACB.

All EDO ACBs ready to close indication contact which shall be used to give a single indication via indicating lamps on panel door if ACB is ready to be closed, after checking all the given conditions (UV release energized, Shunt release de-energized, spring charged, Breaker is not "ON", Breaker has not tripped on fault, Breaker is not mechanically interlocked with other breaker and ACB is not racked in completely in service position) ensuring safety for user and electrical distribution.

ACB shall comply with the environmental directives like RoHS.

PERFORMANCE:

ACB shall have the breaking performance Ics = Icu = Icw (1sec) = 50kA

ACB shall have minimum Mechanical life of 20000 operations

The operating mechanism of ACB shall be of the Open/Closed/Open stored-energy spring type. The closing time shall be less than or equal to 70ms, and of fast opening type with break time of breaker should be <30ms to ensure higher life of distribution cables.

ACCESSORIES & AUXILIARIES:

Shunt trip and closing coil (having common AC/DC supply upto 250V) shall be continuous rated. For Incomer ACBs delayed type under voltage release shall be used to avoid nuisance tripping during voltage surges.

ACBs shall have minimum 4 change-over auxiliary contacts, available to be used for indication and interlocking, rated at minimum 10A 240/380V 50 Hz and shall be wired on chassis/cradle. There should be facility to add one more set of 4 contacts if required

Pre wired Fault trip contact should be provided with Release as standard.

Indication lamps to be provided on front door of ACB feeder shall be as shown below: -

Spring charge indication required for EDO ACB only

SAFETY:

Draw-out ACBs shall preferably be provided with a mechanical latch on chassis which latches the ACB at Connected-Test-Disconnected positions while racking in and racking out the circuit breaker. This feature will help the operator in placing the circuit breaker at right position inside the chassis and can help in avoiding the accident.The racking handle of the breaker shall be stored on the air circuit breaker in such a manner as to be accessible without defeating the door interlocking.

TERMINATIONS:

All air circuit breakers shall be fully tropicalized as standard & suitable for terminating copper or aluminium bus bars. Both fixed & draw-out circuit breakers shall have single pole-pitch. ACBs upto 3200A shall be provided with top horizontal and bottom vertical terminal adapters on both sides for proper cable connections/bus duct connections. Terminal orientation for top and bottom side shall preferably be possible to be changed from vertical to horizontal or vice versa on site as per cable/bus duct entry. Rest of the ACBs shall have both side vertical terminal adaptors for better heat dissipation.

PROTECTIONS:

Air circuit breaker shall be provided with microprocessor release, which should be self powered type without the need of any auxiliary power supply during normal operation of the breaker.

The circuit breaker control unit shall measure the true r.m.s value of the current circuit breaker trip unit shall have a display for measurement of current and voltage. It shall be possible to view last 5 trip cause on trip unit.

All trip units provided shall have thermal memory as standard

All trip units shall be EMC/EMI tested

The protection release shall have following protections as standard: -

Adjustable over load current (Ir) settings from 40% to 100% of rating of ACB (In). Over load time setting (tr) from 0.5s, 1s, 2s, 4s…….24s as field selectable curves.

Short circuit setting (Isd) from 1.5 to 10 times of Ir setting, Short circuit time delay adjustable from 0 to 400 msec.

Instantaneous (Ii) protection with an adjustable pick-up and an OFF position.

Earth fault setting adjustable in absolute Ampere with time delay settings from 0 to 400ms.

Separately powered, individual fault trip indication LEDs (For overload, short circuit, earth fault and trip unit failure) shall be available on the trip unit which shall function even if the display fails.

I2t ON / I2t OFF options shall be available for short-circuit & earth fault protections which can be used to ensure discrimination with upstream circuit breaker or fuse.

The trip unit shall have integral test facility to verify the healthiness and to avoid external calibration.

It shall be possible to change the protection settings on line and the circuit breaker need not be switched off while adjusting the settings.

All ACBs in main LT panel shall surely be provided with zone selective interlocking which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate between incomer breaker and outgoing breakers enabling zone selective interlocking. The manufacturer shall supply all equipment like ZSI module, power supply and wiring connectors to implement ZSI.

It shall be possible to view the percentage loading of three phases at once on trip unit via LEDs or LCD display to help the user in identifying the current load balancing of the network. This will help in preventing the deterioration of loads affected by load balancing by identification of the balancing related issue.

All 4 Pole ACBs shall have fully rated neutral equal to rating of the breaker & shall be protected against over-load faults with provisions for settings neutral unprotected, neutral protection at 0.5In and neutral protection at 1.0 In to ensure precise neutral protection.

MOLDED CASE CIRCUIT BREAKER (MCCB)

GENERAL:

MCCBs shall comply with standards IS/IEC 60947-1 & 2. The breaking capacity performance certificates shall be available for category A to the above mentioned standards.

MCCB shall have a rated operational voltage (Ue) of 415V, insulation voltage (Ui) of 690 V (AC 50/60 Hz) & impulse voltage (Uimp) of not less than 8kV.

MCCBs shall be current limiting type preferably having an encapsulated double break design having two fixed contacts, one moving contacts and two arc chutes per pole. The design is required to minimize the effects of short circuit currents i.e. limit the let through energy and improve the life of cables.

MCCB shall not have any line load bias

MCCB shall comply with the environmental directives like RoHS and WEEE

800A and above rating MCCBs - shall be microprocessor based, category B type (drawout design in main panel and fixed type in sub panels) having Icw (1sec) not less than 15kA. Microprocessor trip unit shall measure current and voltage data with last 5 trip records. Microprocessor based MCCBs in main panel shall have zone selective interlocking feature. Mechanical life shall be 10000 operations.

PERFORMANCE:

The MCCBs shall have a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at 415V and as per system fault levels (refer SLD).

The limiting capacity of a circuit breaker is expressed by two curves which are a function of the prospective short-circuit current (the current which would flow if no protection devices were installed): The thermal stress (A2s), i.e. the energy dissipated by MCCB during fault should be as low as possible. Cable selection to be done as per Maximum permissible cable stresses for which manufacture should produce current limiting and energy limiting curves of MCCB's.

SAFETY:

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries (ON/OFF/Trip Contact, Shunt, Under Voltage etc.). All poles shall operate simultaneously for circuit breaker opening, closing and tripping. MCCBs shall be actuated by a toggle or rotary-handle that clearly indicates the three distinctive positions: ON, OFF and TRIPPED. MCCB shall clearly indicate the suitability for isolation in the name plate identified by the symbol 

MCCBs shall be equipped with a “push to trip” button in front to test operation and simultaneous opening of all poles together.

MCCBs shall be designed to prevent access to live parts when the cover is removed , means main current path of the circuit breaker should be isolated from auxiliary section i.e. MCCB shall offer class –II front face as per IEC standards 61140 and 60664-1

The electrical life of MCCBs shall be 8,000 operations up to 250A & 4000 operations up to 630A.

All MCCBs provided shall be of single frame size upto 250A to reduce the requirement of spares management.

All MCCBs shall have cross bolted type termination where bus bars or cable lugs can be terminated by crossing the bolt between the lugs/bus bars and MCCB connections, to enhance safety and reliability of the terminations. In case spreaders/rear connectors are used in between MCCB and bus bar/lugs then the spreaders shall be cross bolted with the MCCB connectors.

AUXILIARIES AND ACCESSORIES:

Following separate Field installable auxiliary contacts for signalizing different functions shall be provided with all MCCBs

open/closed position contact

trip signalling contact

Electrical fault trip signalling contact

Rotary handle shall ensure IP40 for direct type and IP 55 for extended Rotary handle.

MCCB shall have provision for Rear connection - MCCB mounting on a back plate with suitable holes enables rear connection. The rear connections are simply fitted to the device connection terminals.

PROTECTIONS REQUIREMENTS:

MCCBs shall have thermal magnetic trip units upto 250A and microprocessor trip units above 250A.

Thermal magnetic trip units shall have variable overload settings from 0.7 to 1 Ir and fixed short circuit settings

Microprocessor trip units shall have variable overload settings from 0.5 to 1 Ir and variable short circuit settings from 2 to 10Ir

In case of 4 pole microprocessor based MCCBs neutral shall be protected & adjustable as a Neutral unprotected / Neutral protected at 0.5 In/ Neutral protected at In.

MCCB’s should be provided with auxiliary contacts for signalling different functions, as: open/ closed position, fault signal and shunt trip coil for remote/emergency tripping of MCCB.

Where ever it is required based on electrical distribution network need, MCCB shall have Earth Fault Protection as a provision. MCCB Earth Fault Protection should have following settings and features:

Selection of Ir MCCB rating

Earth fault sensitivity selection from 20% – 60% In.

The time delay selection in case of Earth Fault from 0.5 to 3 Sec/ instantaneous.

There shall be a separate fault differentiation indication (LED) for Over current and Earth fault. Indication for over current and earth fault tripping shall be extended to the panel door via indication lamps. Separate LED shall be there to show healthiness of earth fault protection system

EF protection module shall be suitable for 3P 4W system. It shall take the input from neutral for correct earth fault protection.

Earth fault module shall have auxiliary contacts for earth fault signalling.

HYBRID POWER FACTOR CORRECTION PANEL

SCOPE

Design, assembly / fabrication, installation, testing and commissioning of 3 phase, 440 V, 50 Hz TP&N PFC system (Auto + manual option) with Super Heavy Duty type capacitors, microprocessor based controller and Copper wound detuned filter. The unit shall improve the monthly average power factor and mitigate harmonic distortion on the LV bus.

ENCLOSURE

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved color shade/s to match the color of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

There should be compliance for the following:

IEC61921: Power capacitors–Low voltage power factor correction banks.

IEC 61439-1: Low-Voltage Switchgear and Control gear Assemblies - Part 1: Type- Tested and PartiallyType-Tested Assemblies.
IEC 62208: Empty enclosures for low-voltage switchgear and control gear assemblies – General requirements
IEC 62262: Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
IEC 61326-1 : Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements.
IEC 61000-6-4: Electromagnetic compatibility – Generic standards – Emission standard for industrial environments

HPFC PANEL OPERATION:

The HPFC panel shall, in its default configuration, shall implement the following features through an integrated controller. The integrated controller shall ensure that the reactive current requirement of the base load shall be drawn through the capacitors and the additional requirement shall be automatically catered through active filter ensuring stepless compensation of reactive current. The entire system should function like a single unit delivering complete benefits to the end customer with respect to the below mentioned parameters:

Step-less Power Factor Correction (for both leading and lagging current), Control response time : 25μs

Harmonics Compensation up to 51st order (2nd priority)

Load Current Balancing in the three phases (3rd priority)

THE HPFC PANEL SHALL COMPRISE:

Incomer

A suitably sized as indicated in boq three pole MCCB or ACB having microprocessor based over-current and short-circuit protection and at least 50kA breaking capacity (100% Ics) as the incomer of the panel.

Metering and Indication

R, Y, B indication lights for the incomer ACB / MCCB

On, Off & Trip indication lights for the incomer ACB / MCCB

A digital multifunction meter showing voltage, current, frequency, PF, THD, kW, kVA, and other related parameters

Three number of cast resin CTs of suitable rating

One number of three phase digital ammeter showing current in three phases of HPFC panel

An active filter part and a passive filter part; the ratio of the rating of active filter to that of the passive filter shall be at least 1:1

The exact distribution of total capacity between the active and passive part shall depend on the rating of the HPFC panel. In this case, we have require a minimum of 400 kVAR (650 Amps) IGBT based active power filter and 350 kVAR detuned capacitor banks integrated together through a single controller to achieve hybrid power factor correction system.

ACTIVE POWER FILTER

The Active Power Filter (Type APF) is intended to remove harmonic distortion from the phase conductors in a 3-phase electrical system resulting in reduced phase current, reduced current distortion and reduced upstream electrical system harmonic voltage distortion.

PRINCIPLE OF OPERATION

APF should measure level of harmonics in supply line and eliminate it by generating the counter harmonics. It should employ a DSP which determines the harmonic current amplitude to be injected in the opposite phase angle of each harmonic order. Along with harmonic compensation, it should be able to take care of power factor (lead and lag) and unbalance correction at the point of connection.

The active filter shall not only provide harmonic mitigation, but also, power factor correction and load balancing. Harmonic correction, PF correction and Unbalance correction should be able to set with priority.

The active harmonic filter shall mitigate harmonics from the 2nd harmonic up to the 50th harmonic and limit harmonic distortion at their point of connection to within the harmonic limits specified herein. The active filter shall be connected in parallel (shunt) to the load.

The active filter shall be suitable for connection at an electrical distribution panel, transformer secondary or at an individual load.

The active filter shall be suitable for connection to a distorted voltage source and its operation shall not be adversely affected by pre-existing voltage distortion.

The active filter shall be suitable for operation on an electrical system having a generator as its power source.

AHF should have high attenuation greater than 97% of individual harmonics

AHF shall allow selection of any 20 order of harmonics out off 2nd to 51st harmonics order.

It should be possible to use filter for single harmonic elimination

PF compensation should be leading as well as lagging

APF should be capable of unbalance correction

ESSENTIAL REQUIREMENTS FOR THE POINT OF RELIABILITY

For capacities above 200 Amp onwards the filter design should adapt modular construction

The display should be Touch screen SVGA display with true RMS values. The wave form should be visible on the display.

High grade cooling blowers shall be used.

In case of future repair requirements, the same shall be done through card level replacement and not the whole module

ELECTRICAL RATINGS:

System Voltage: 400V AC ± 10%, 3ph 4 Wire/3 wire

Line voltage tolerance: ±10%

System Frequency: 50 Hz

Frequency tolerance: 50 Hz ± 5%

Harmonic Cancellation Current: [30, 60, 75,100, 150, 200, 300, 400, 600 amps]. Multiple filter units for parallel connection may be used to achieve total current requirements for combined power factor correction and harmonic mitigation.

Possible units of same ratings connected in parallel: Infinite.

Current transformers shall be with Class 0.5 or better with 15VA rating.

Flexibility to select CT ratio shall be also be available.

Surge withstand capability per ANSI/IEEE STD C62.41-1991.

Should comply with IEC/IEEE 62040 – 2 category C3.

The Active harmonic filter shall be of certified design confirming to IEC 60529, CE

EMC Certification IEC/EN 61439-1, As per International Standard: cULus (UL508, CSA 22.2 No. 14), CE Certified, ABS,CE EMC Certification IEC/EN 60439-1, EN 61000-6-4 Class A, EN

61000-6-2, Seismic rating: Complies with IBC and ASCE7

BASIC PRODUCT REQUIREMENTS

The active harmonic filter shall meet the following basic requirements:

Active filters shall include input surge suppression.

Active filters shall include forced air cooling system.

Active filter shall be able to connect in both open loop and closed loop configuration

Active filter should have a HMI touch screen display having the functionality of a power analyzer and should display parameters as mentioned below:

Current Parameters: Arms, A1rms, iTHD (%), Aunb

Voltage Parameters: Vrms, V1rms, Urms, vTHD (%), Vunb, Frequency

Power Parameters: Active, Reactive, Apparent Power

Power Factor

Displacement Power Factor

Filter Parameters: Apk, Filter Utilization, Stack Temperature, DC Voltage, Filter Runtime, Fan Runtime, Panel Temperature

Voltage and current waveforms

Voltage and current Harmonic spectrum

Alarm indications & log details

Product warranty period shall be one (1) year.

Active filter shall be isolated from the power supply when powered "off".

IGBT modules shall be self-protected for maximum reliability.

The response time shall be at least 25μs and the correction time shall be less than 10 ms

AHF shall have auto fold back feature.

Construction:

Constructed on metal panel with minimum IP 42.

Filter shall be suitable for operation upto an ambient temperature 45oC with suitable ventilation and shall give an alarm signal in case of temperature going beyond a set limit.

Shall be able to work with higher temperature with automatic de-rating (80% capacity at 50oC)

Storage temperature shall be from 0oC to 70oC with suitable packing

Active filters shall be suitable for operation in relative humidity up to 95% non-condensing.

Panel shall have an audible noise level lesser than 65db

Panel shall have a filtering efficiency of at least 97%

Panel shall have a reaction time of at least 25 micro-seconds

Power factor correction shall always be set at priority

Priority selection between the remainder features - harmonics compensation and load balancing - shall be programmable at the time of commissioning. In the default mode, harmonics compensation is set at 2nd priority and load balancing is set at 3rd priority

Auto fold-back of the HPFC panel if total current requirement exceeds the rated capacity of the panel

All live parts of the system shall be properly shrouded

Inspection terminal strip, number ferruling, and other labeling shall be suitably provided

Stickers marked with "DANGER" shall be provided wherever required

Detailed drawings and manuals shall be provided wherever required

Following protections shall be provided:

Over voltage (AC) protection

Over voltage (DC) protection

Phase sequence protection

Over current protection

Over temperature protection

Protection circuits for the inverter stack and its components

All components and wiring used in the system shall adhere to the relevant ISI and IEC standards

SWITCHGEAR & PROTECTION

Incomer switchgear shall be TP&N breaker appropriate rating. Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Bus bars shall be suitably color coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures up to 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

CONTROL CIRCUIT & GENERAL PROTECTION

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

CAPACITORS

The capacitor shall comply with the following standards (and their latest amendments): IS 13340-1993, IS 13341-1992, IEC 60831-1+2

General specifications: 3 phase, delta connected, 50 Hz.

Voltage: Must be designed to withstand system over voltage, increased voltage due to series reactor and harmonics.

Capacitor type: Super heavy duty with double side metalized capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnector in each individual capacitor cell.

Over voltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.

Over current: 2.5 x In

Peak Inrush current withstand: (350) x In

Total watt-losses including discharge resistors: <0.45 W / k V Ar.

Temperature category: -25 deg.C to 65 deg.C.

Capacitor shall be self-heating type and oil impregnated for longer life. The impregnate shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing.

The design shall be modular for simple mechanical assembly, no extra accessories/ metal parts to be required. Unit must be free standing with an IP 42 protection level.

CAPACITOR CONSTRUCTION

Capacitor Unit

Each step in the Hybrid power factor correction panel shall comprise of single unit or group of units connected in parallel to form a bank. Each capacitor unit / module shall be provided with Pressure Sensitive Disconnector or inbuilt fuses for safe

disconnection. Each capacitor unit shall comprise of number of single-phase elements connected Delta configuration. All capacitor unit shall be provided with discharge resistors, which shall discharge the capacitors to less than 50 V within 1 minutes.

Capacitor Elements

Each element shall be wound from continuous reels of high quality polypropylene film combined with dual side metalized paper in the dielectric structure to form a cylindrical winding. Elements shall be vacuum dried, impregnated under high vacuum with non PCB oil.

SERIES REACTOR

Application

LV Harmonic Filters Copper Wound 14% reactor shall be used with harmonic filter duty power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks. Capacitor voltage shall be minimum 525 V when used with 14% reactors.

Construction, Testing & Protection

The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use (IP 00). The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin and shall be suitable for temperature Class H (T60/H) operation.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC 60076/3.

The permitted tolerance of inductance shall be + 3% of rated inductance value.

Reactor tuning factor shall be 14% and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor shall be as follows $1.2 \bullet \sum I\eta$ with $L = 0.95\ LN$

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

DIESEL GENERATOR SETS

INTENT OF SPECIFICATION:

This specification covers the design, manufacture, assembly, packing, dispatch, transportation to site, supply, erection, testing, commissioning, performance and guarantee testing of Diesel Gen-Sets, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

SCOPE OF WORK

Scope of Supply & Services:

General Scope of work shall include design, manufacture, assembly, packing, dispatch, transportation to site, supply, erection, testing and commissioning of the following:

Diesel engine complete with all accessories, an Alternator directly coupled to the engine through flexible/rigid coupling complete with all accessories for starting, regulation and control, including base frame, interconnecting piping and accessories, power and control cable, glands and lugs etc.

D.G. Local/Remote control panel including all type of control cables, special cables (if any) between D.G. Set's, instrument panel, PLC control panel and Main LT panel etc.

Equipment necessary for engine cooling system, heat exchanger, pumps, valves, inter connecting pipes etc.

Equipment necessary for fuel storing and distribution, day oil tank (990 Lt.), pipings, pumps, valves, level indicators etc.

Exhaust piping, flexible connections and residential type silencer of exhaust system, including thermal lagging, cladding etc.

Batteries with good quality iron battery stand and battery charging equipment, including their connections as necessary, along with tools & accessories for battery maintenance. (Contractor shall submit the list of tools along with Tender)

Anti Vibration Mountings etc.

Cooling Towers including fans, motors, weatherproof isolator enclosure, isolator etc.

Cooling tower pumps etc.

Cooling system piping including controls & accessories etc.

Electrical panel for local equipment, cooling tower pumps etc.

Power & Control cabling, cable tray etc.

Preparing all related shop drawings for approval from NBCC/consultant and all statutory bodies as required and as applicable.

Obtaining statutory approval of the installation including permission for operation of Diesel Generators by the Electrical Inspectorate, Pollution Control bodies and any other statutory bodies as applicable.

Minor civil works like chasing, grouting etc. for execution of jobs.

Carrying out performance and guarantee test at site at available load which shall not be more than the capacity of D.G. Set.

CODES AND STANDARDS

The equipment furnish under this specification shall conform to the latest Indian and BS Amendment upto date standard, except where modified or supplemented by this specification:

The installation work shall conform to Indian Electricity act and Indian Electricity Rules as amended upto the date of installation.

The fuel oil installation shall meet all statutory requirements of Govt. of India as amended upto the date of installation. Any approval required from statutory authorities shall be obtained by the Contractor. Nothing in this specification shall be construed to relieve the contractor of these responsibilities.

The Indian standards are available from:

Indian Standards Institution

Manak Bhawan,

9, Bahadur Shah Zafar Marg,

New Delhi - 110 002 (INDIA).

The Indian electricity Rules and the Electricity act mentioned above can be obtained from:

Kitab Mahal,

State Emporium Building,

Baba Kharak Singh Marg,

New Delhi - 110 001 (INDIA).

Equipment conforming to any other National/International Standard which ensures equal or better quality may be accepted. In such case the bidder shall furnish copies of the standards in English along with his bid and shall clearly bring out the salient features of comparison with corresponding listed standards.

The equipment furnished under this specification have to operate in a tropical climate and shall be given tropical and fungicidal treatment as per relevant specification

PERIOD OF OPERATION/DUTY CYCLE

The sets are intended to supply power only during an emergency for all services and may be idle for long periods except for periodic routine tests once in a week. When there is a total failure of main power supply, the sets shall be required to operate continuously at full load for a period which at times may exceed even 24 hours.

ENGINE

Type:

The diesel engine shall be of stationary type four stroke (Prime Duty) with vertical in line or (V) type cylinder arrangement, Turbo-charged, cooled with Heat Exchanger.

Rating:

Power BHP rating of the engine shall be such that the DG set deliver the specified net electrical output while supplying power/driving all electrical and mechanical auxiliaries connected to alternator terminals and engine shaft at specified site conditions and ambient temperature of 50OC. (The engine and alternator shall be suitably rated for 50OC ambient operating condition.

It shall also be capable of satisfactorily driving the alternator at 10% over load at the rated speed for one hour in any period of 12 hours of continuous running.

The bidder shall have to furnish copy of deration chart from the original manual of the engine manufacturer and supporting calculations to arrive at diesel engine rating.

Speed and Vibration Levels:

Speed shall be 1500 revolutions per minute. Speed governor/over speed protection shall be provided. At due running conditions, speed shall be stabilized at plus or minus 2% nominal speed, regardless of load. At transient condition, engine speed shall vary not more than 10% plus or minus. Governor class shall be A1 (4% drop) for normal application unless otherwise specified.

The engine vibration level shall be as latest upto date amended BS standard.

Lubrications:

The engine shall have a closed cycle forced & splash lubricating system with positive oil pressure and a crank chamber for collection/storage of the lubricating oil during circulation. Lubricating oil shall be circulated in the engine by an engine driven pump.

A lubricating oil filter of an efficient full flow type of ample capacity shall be provided for operation under normal conditions for a period of 300 hours without the necessity of its replacement or cleaning. Filters shall be capable of removing all foreign matter above a particle size of 5 microns.

In case lubricating oil coolers are required it shall be supplied as an integral part of the Diesel Generator Set.

Necessary temperature and pressure gauges and other instruments shall be supplied and fitted on the lubrication system.

A lubricating oil level dipstick suitably graduated shall be provided and located in the accessible position.

The tenderers shall state the guaranteed lubricating oil consumption in litres per hour.

Fuel System:

The engine shall be capable of satisfactory running on all types of diesel fuel oil normally available locally/ in India.

If guaranteed fuel consumption is exceeded, the contractor shall make such amendments or alterations as are necessary to bring the consumption to within the guaranteed figures. Tolerance of +5% as defined in latest upto date BS shall be allowed.

A fuel service tank of 990 liters capacity with each D.G. Set shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in liters, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. All pipe joints should be brazed/welded.

Air Intake System:

The diesel engine shall be provided with special dry type air filters having low resistance to air passage, high dust retaining efficiency and provision for easy cleaning. Filters shall be suitable for achieving satisfactory engine operation and ensuring the engine life under tropical humid conditions, with sulphur dioxide fumes, abrasive dust and coal particles of 5 to 100 microns present in the atmosphere. The minimum efficiency of filters shall be 90% down to 5 micron size.

Engine Governor:

The governor shall be Electronic ISO-Chronous type to maintain zero speed rate or regulation and shall be Al type as per latest BS in order to take care of heavy motor starting. It shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However, a tripping shall be provided if speed exceeds maximum permissible limit. The governor shall be suitable for operation without external power supply.

Turbo Charger:

It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

Quietness Of Operation:

The engine shall be designed to achieve maximum quietness of operation.

Efficient residential silencer shall be provided as per engine manufacturer’s approved make only for the exhaust.

Noise level of the DG set shall be as per The CPCB Norms

Engine Starting:

Engine starting shall be by electric starting motor complete with manual/automatic starting arrangement. The starter motor shall conform to latest IS and shall be of adequate power for its duty and be of inertia or pre-engaged type. The pinion shall positively disengage when the engine starts up or when the motor is de-energized. The engine cranking shall be only from the panel both for AMF & DG sets (Manual) and any engine starting devices etc. that are given as original fitment on the engine by engine manufacturers

shall be either removed or padlocking arrangement given for this so that all normal start/stop operations could be done only from panel whether the set is AMF or manual.

The engine wiring shall be appropriately modified, ferruled to totally match with schematic drawings of the panel.

Time for Run-up to Speed:

From the initial operation of the starting device, the engine shall start, run up to normal speed and be capable of accepting 60% of full load in steps within a maximum time of 20 seconds, and full load within a further 20 second.

Starter Battery:

The battery shall conform to the requirement of latest IS. Starting battery each of 12 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery set shall be capable of performing at least (5) five normal starts without recharging.

The battery shall be provided with good quality iron battery stand painted with acid proof black paint with min 3mm thick rubber mat below the battery.

Batteries shall be of load container type only and not with PVC moulded sealed container so that each individual cells are available for individual monitoring during its life span. Each cell shall be provided with electrolyte filling cap with level floats for easy monitoring of electrolytic level.

The battery shall be provided with 2 Nos. cables, minimum 1.5m long heavy duty rubber/PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.

The lugs shall be clearly stamped (+) or (-) and positive cable also red sleeved for easy identification.

The batteries Set shall be supplied fully filled and first charged ready to use.

Batteries set shall be supplied with spring type hydrometer, thermometer with specific gravity correction scale and cell testing voltmeter etc.

BATTERY CHARGING SYSTEM

Float rate charging and quick rate charging system shall be provided at the generator panel with appropriate bridge charger system, LC network, rate selector switch and generously rated charging transformer and silicon one rectifier bridge, so that the cranking battery system can be kept fully charged at all times from E.B. supply network with quick charging rate limited to 0.8 times rated discharge current with provision in control transformer and Si rectifier present to enable boost charging the battery at 2 times rated discharge current in case of emergencies. To this and in the mode selector switch boost charge position shall be present which however shall be kept disconnected at mode selector switch normally.

DC ammeters to clearly indicate float charging current and quick/boost charging current shall be provided.

Dropper resistor network on the load side of battery charger system shall be provided so that higher charger voltages in quick or boost conditions does not get impressed on the I/L and Contactor coils, which voltage shall remain well within +10% of rated voltage.

Battery charging subsystem shall be designed for continuous operation at cubicle ambient of 50OC corresponding to 45OC ambient outside and should be designed to operate at 1.5 times rated maximum current corresponding to boost charge current which can reach in practice as high as 2.5 times or 3 times rated discharge current.

Any charger dynamo and dynamo charging current network present on the set shall be made in operative so that both for AMF and manual application the cranking battery system is kept charged from the charger at the panels at all times during or shut down periods of the set.

To the above and in case of manual DG sets, the input to charger subsystem viz., 240 V AC is foreseen to be provided from customer network from the portion that is normally supplied by manual DG Set during DG operation or being fed by E.B. System.

Battery charger shall form part of D. G. protection and PLC panel.

ENGINE FITMENTS

The engine shall be provided with but not limited to following essential basic fitments:

Crank case breather - Dry type element (Breather outlet shall be fitted with a filter cap capable of preventing entry of dust).

Air Cleaner - Dry type mounted.

Corrosion resistor - to control acidity and impurities from coolant

Lubricating Oil Cooler -

Filters - Lub oil & fuel oil, paper element type.

Coolant Pump - Gear Driven.

Fuel Pumps - Priming & Transfer

Governor - Electronic Class A1.

Turbo Charger - Exhaust gas driven in case of turbo charged engines.

Flywheel with flywheel housing - SAE Type

Vibration dampers - One Set

Exhaust/Intake manifolds -

Oil Sump (crank case) with dip stick

Engine Supports

Residential type silencer in exhaust system

Electrical starter 24 V

Safety controls & instruments

Flexible coupling with guard

Engine Instrumentation

The following instruments mounted on instrument panel shall be essentially present as minimum:

Engine speed tachometer with service hour counter

Lube oil pressure gauge

Coolant water temperature gauge. The engine shall be standard design of the OEM, engine shall develop suitable BHP for giving power rating as per ISO 8528-Part I in KVA.

The instrument panel shall be mounted on engine using rubber dampers for vibration isolation.

The gauges shall have clear red marking to identify the limiting dangerous levels, `Zone Markings' on the scale to indicate the normal healthy & abnormal operating zones for the parameters concerned.

The metering could be either normal electro-mechanical analogue type or electronic digital type, latter being preferred as manufacturers fitment only.

The engine control panel must be supplied by the engine manufacturer only.

MOUNTINGS AND FOUNDATIONS

The engine and direct coupled attenuator shall be rigidly secured to a common rigid base frame fabricated from MS section.

The DG set shall be placed on the RCC floor with approved make anti-vibration mountings. A lifting hook of required capacity shall be provided above the finalized location of the DG set to facilitate installation and subsequent maintenance of the DG Sets.

The design of mounting arrangement with anti-vibration mountings shall be as recommended by the DG manufacturers and shall be such that a maximum of 2% vibration are transmitted to the structure.

EXHAUST PIPING:

The engine shall be fitted with a residential type silencer (design approved by manufacturer) to reduce the noise level. Silencer outlet shall be connected to exhaust piping carried to the top of the building through shafts provided for the purpose. Exhaust piping shall be fabricated from class 'B' MS pipes of size suitable to limit back pressure to within permissible limit

(2.5" of Hg.). It is important to ensure that the surface temperature of the exhaust piping does not exceed 50OC. For this purpose, the entire length of exhaust piping shall be treated as mentioned in the Bill of Quantities.

Exhaust piping shall connected to the engine by means of flexible section or an expansion joint and shall also be graded to a drain pocket inside the building. The pocket shall be fitted with a drain cock.

TOOLS:Two sets of standard tools kit for maintenance shall be provided by Contractor.

SAFETY CONTROLS:

Low Lubricating Oil Pressure:

Pressure sensors shall be fitted such that in the event of a fall in the lub oil pressure, an alarm and indication shall be actuated. In addition, the engine shall be automatically shut down in the event of lub oil pressure dropping to a predetermined low value.

Over Speed:

Speed control shall be so arranged that a 10% increase over normal rated speed shall cut off fuel supply, thus stopping.

Overload Protection:

The engine shall be adequately protected against operating under overload conditions. The requirements shall be met by the provision of a fixed overload limit stop on the fuel pump rack control rod to prevent the set being subject to a load exceeding the site rating plus 10%.

I.e. 10% for one hour in every 12 hours of continuous use.

Excess Starting Time:

The starting circuit for the automatic mains failure diesel generator sets shall be arranged to attempt upto three starting cycles, each not exceeding 10 seconds duration with a similar OFF period between each cycle. If the set fails to start upon completion of the third attempt the starting circuit shall be locked out until it is restored manually. An alarm shall be given and "Set failed to start" indication given on the panel.

Fuel Level Protection:

A level sensor shall be provided in the day fuel tanks to give visual and audible alarms if the level in the tank falls to below ¼ of full.

ALTERNATOR:

The alternator shall have brushless type with rotating field and static excitation circuit controlled by field control unit suitably compounded for voltage and load current for a self excited self regulated system.

The alternator shall be in SP-DP enclosure, foot mounted with ball and roller bearings on end shields.

The alternator shall conform to latest IS/BS and shall be suitable for tropical conditions.

The alternator shall comply with the following specifications:

Rating - 1 No.x 750 & 1 No. 320KVA DG Sets

Shall be capable of 10% over loading at the rated speed for one hour of 12 hours continuous running without exceeding permissible temperature rise.

Phase - 3 phase, 4 wire

Voltage - 415 V

Regulation - To be filled by the Tenderer

Speed - 1500 RPM

Frequency - 50 Hz.

P.F. - 0.8 lag or amended up to date, as recommended by OEM.

Enclosure - IP:23

Insulation - H

Execution - Self excited, self regulated with brushless system and separately excited with PMG static voltage control unit suitably compounded for voltage and current to maintain terminal voltage constant at ± 5% at all load for p.f. not less than 0.8. lag.

Terminal Box - Bus duct chamber

Earthing Studs - 2 Nos. for each DG Set.

Neutral Point:

The winding of the alternator shall be star-connected with the neutral connection brought out to a separate terminal.

Terminal Box and Connection:

The alternator output terminals shall be enclosed in a terminal box mounted in an accessible position on the alternator frame. As far as possible, connections between the exciter and alternator shall be contained within the machine frame and connections carrying A.C. and D.C. shall be segregated from

each other. The terminal box shall be of sufficient size to conveniently terminate the size and number of the Owner's cables, which shall be intimated during detailed engineering. Suitable tinned copper pads shall be provided for power cable termination along with all necessary hardware and cable lugs. Glands and lugs shall be provided for control cables also. For single phase cables, gland plate shall be of non-magnetic material. Gland plate shall be removable type.

The generating set shall be so designed that it is capable of reaching its full voltage and frequency and shall be ready to take full load within 30 seconds of a remote starting impulse being received.

ENGINE SAFEGUARDS:

Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:

Energising a solenoid coupled to the stop lever on the fuel injection pump rack.

De-energising the "fuel on" solenoid

Energising the "fuel - cut off" solenoid.

The operation of the safeguard shall at the same time give individual warning of the failure by illuminating an appropriate local visual indicator and remote alarm at generator panel.

The contactors, relays and other devices necessary for signal and control, for above purposes shall be provided at Generator panel.

At the set at a easily accessible place an "EMERGENCY STOP" mushroom head stay put type P.B shall provided to stop the set in emergency mode.

The safe guard to "STOP THE SET" shall stop the set irrespective of mode selection of the set viz Auto, Manual or test for following cases, with simultaneous isolation of alternator ckt.

Emergency stop P.B's operation

Over speed.

Low lube oil pressure.

Earth fault

Over current

High water temperature

Type of AVR - Electronic

TESTS:

The alternator of each type and rating shall be type tested for the following tests as per latest IS/BS. Test certificates to be provided for routine and type tests from the manufacturers.

ERECTION, TESTING, COMMISSIONING AND PERFORMANCE & GUARAANTEE TESTS/PROCEDURE AT SITE:

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The supervisor(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommend by the contractor.

The contractor shall ensure that the equipment supplied by him are installed in a neat workman like manner such that they are levelled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner.

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the contractor.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to dispatch of the equipment.

The contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.

Commissioning Check Tests/Performance and Guarantee Test:

In addition to the checks and test recommended by the manufacturer, the contractor shall supervise the following acceptance tests to be carried out on each test at site.

Load Test:

The DG Set shall be given load test at site for a period of at least 6 hours depending upon the actual power factor of the load and set shall be subjected to the maximum achievable load without exceeding the engine or alternator capacity.

This full load test is to be followed immediately by a 10% overload run for one hour.The performance of the engine, alternator shall be satisfactory at the end of this overload run.

During the load test half hourly records of the following shall be taken:

Ambient temperature

Lubricating oil pressure.

Speed

Voltage, wattage and current output.

Oil tank level

Speed and Governing:

The speed of the engine shall be verified to ensure that it conforms to the requirement of latest BS.

Check of Fuel Consumption:

A check of the fuel consumption shall be made through out the test run of constant full load and constant overload.

Noise Level:

The noise level shall be as per latest CPCB norms.

RADIO INTERFERENCE:

All equipment provided under this specification shall be so designed that it will not cause interference with radio equipment. In the event of the inherent characteristics of the equipment being such that radio interference is possible, efficient devices to nullify the same shall provided. Suppressers shall be as per the relevant latest IS/BS Standards. Nothing extra shall be paid to the contractor on this account.

PRE-COMMISSIONING CHECKS:

All standards checks including the ones elaborated in the specifications to ensure that the installation of the DG sets and associated systems has been carried out satisfactorily shall be done on completion of installation. These shall include:

DG Sets:

Checking of piping interconnections

Checking of electrical interconnections

Checking of insulation resistance

Checking of earthing

Checking of instruments and controls

Checking of alignment

Checking of vibration transmission to building a structure

Checking of expansion joints

Cooling Water System:

Checking of piping interconnections

Checking of electrical interconnections

Checking of insulation resistance

Pressure testing of piping

Exhaust System:

Checking of silencer operation

Checking of surface temperature of exhaust piping

Checking of back pressure.

Fuel System:

Checking of automatic operation of fuel transfer pumps

PERFORMANCE TESTING AND TYPE TESTS:

Performance Testing:

DG sets shall be tested at varying loads at manufacturers works prior to dispatch of the sets to site. The performance tests at the works shall be carried out in presence of authorized representative from the Owners to enable them to arrange for their representatives for his inspection to be at manufacturer's works for this inspection and testing. Inspection waiver shall be solely as per owner wish.

The performance test on each DG sets shall be of minimum 8 hours duration.

All instruments, materials, consumables (fuel oil, lube oil etc.) load and labour required for carrying out of the test shall be provided by the Contractor.

Following test acceptance criteria shall be applicable:

1.	Fuel consumption at 50%, 75%, 100% and 110% load	±5% of guaranteed performance. Actual alternator efficiencies as determined in the manufacturers works tests shall be used as the basis of calculation of specific fuel consumption ratio.
2.	Voltage regulation from no load to full load	±1%
3.	Frequency regulation from no load to full load	±0.5%
4.	Maximum water temperature	±5% of guaranteed performance
5.	Maximum Lub Oil temperature	±5% of guaranteed performance
6.	Minimum Lub Oil pressure	±5% of guaranteed performance

7.	Lub Oil Consumption	±5% of guaranteed performance

Type Test:

Copies of manufacturers type test for the engine and the alternator of all ratings shall be enclosed along with the dispatch of the DG sets.

Exhaust Blower:

The exhaust fans shall be propeller type with steel hub and blades, mounted directly on the shaft of a totally enclosed motor.

The fan blades shall be of pressed steel of aerofoil design for high efficiency and static pressure.

The mounting frame shall be of cast /sheet steel brackets to connect the frame, with the fan/motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.

The fan motor shall be totally enclosed squirrel cage type.

DG CONTROL AND OPERATION:

Operation of DG Sets shall be monitored and controlled by a programmable logic controller (PLC) based logic panel. Vendor shall coordinate the Main MV Panel Contractor.

TECHNICAL PARTICULARS

(Technical Particulars to be filled in by contractor during execution)

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Packager of DG Set	
Standby rating of the DG set based on continuous operation for 365 days in a year at varying loads. The Standby rating as above shall be suitable for continuous operation over an ambient of 50OC. Tenderer to categorically confirm this operation and to furnish design calculation in support of this confirmation.	
DG set to be suitable for 10% overload capacity for 1 hour on 12 hours – over and above the governor capacity being suitable.	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
DG Set Dimensions (LxWxH)	
DG Set Weight (in kgs.)	
Diesel Engines:	
Manufacturer of Diesel Engine	
Manufacturers Model No.	
BHP	
RPM	
No. of Cylinder	
Type of Cooling	
Type of Starting	
Aspiration	
Air cleaner type	
Fuel/Lub Oil Filter Type	
Governor type and class	
Flywheel to suit flexible coupling	
Flexible coupling with guard	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Fuel Pump	
Hot water auxiliary pump with thermostatic control to maintain the water temperature in the engine jacked at 40OC.	
Interconnection wiring, cabling and piping as required	
Max. engine water temperature	
Lub Oil pressure	
Max. Lub Oil temperature	
Fuel Consumption:	
Typical fuel consumption gms/BHP/hr	
50% load	
75% load	
100% load	
100% load	
Fuel consumption figures vis-à-vis alternator electrical output – kWh/litre	
50% load	
75% load	
100% load	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
100% load	
Fuel air compression ratio	
Suitability for locally available HSD	
Suitability of operation of DG set on cheaper fuel like LDO etc.	
Lub Oil Consumption:	
Lub oil consumption at 100% load	
Heat Balance:	
Typical heat balance	
Heat rejected after cooler	
Heat rejected to exhaust	
Heat rejected to Ambient	
Alternator:	
Manufacturer	
Enclosure	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Mounting	
KW Rating	
KVA Rating	
Insulation class	
Temperature Rise under continuous operation	
Excitation unit	
Voltage Regulation no load to full load	
Wave from distortion on full load	
Radio Interference	
Telephone Interference	
Stator winding thermistor with trip	
Space heater	
Single step load acceptance	
Peak motor starting KVA	
Sustained short circuit % of rated current for 10 seconds	
Overload rating for:	
15 seconds	
60 seconds	
10 minutes.	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
30 minutes	
Terminal Box (Yes/No)	
Instruments and Controls	
Instruments:	
Oil temperature gauge	
Oil pressure gauge	
Water temperature gauge	
A.C. voltmeter with 3 way and OFF selector switch	
A.C. ammeter with 3 way and OFF selector switch	
Frequency meter	
Battery charging ammeter	
Hour meter to show total engine hours run – 10000 hr capacity	
R.P.M. indicator	
Switches:	
Emergency stop push button	
Run/off-reset/auto engine start switch	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Manual Voltage adjustment	
Indication Lamps:	
Battery Charger fault	
Low battery voltage	
Emergency stop	
Generator switch not in auto	
Low fuel	
Low water temperature	
Pre-alarm high engine temperature	
Pre-alarm low oil pressure	
System ready	
Safety Controls:	
Safety Control – low lub oil pressure	
Safety Control – high lub oil temperature	
Safety Control – high engine temperature	
Safety Control – Over crank	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Safety Control – Over speed	
Safety Control – Over Voltage	
Safety Control – low water level in cooling towers	
Antivibration Mounting:	
Make	
Vibration Isolation Efficiency	
Exhaust System:	
Exhaust silencer type	
Number of Silencers provided	
Noise level dB at 1m from silencer	
Noise level 1m outside DG room and 1 m from the enclosure surface	
Exhaust pipe diameter, material and thickness	
Guaranteed Temperature on external face of exhaust pipe insulation	
Details of insulation provided for exhaust pipe	
Temperature of flue gases at exhaust manifold	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Expansion joints in exhaust piping	
Exhaust stack height – along with back pressure calculation	
Cooling Tower:	
Manufacturer	
Type	
Model	
Range	
Overall Dimensions (mm)	
Weight with water (kg.)	
Cooling capacity (TR)	
Wet Bulb (Design) (Deg. F)	
Approach to Design Wet Bulb (Deg. F)	
Drift Loss (USGPM)	
Evaporative Loss (USGPM)	
Total Water Loss (USGPM)	
Fan Capacity (CFM)	
Fan Motor HP	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Outlet Velocity (FPM)	
Fan Speed (RPM)	
Fan Diameter (mm)	
Pumps:	
Manufacturer	
Model	
Impeller dia. (mm)	
Capacity – LPM, Head and Motor HP	
Motor Speed (RPM)	
Type & Material of Seal	
Performance Curves (Whether enclosed with Tender)	
Piping:	
Pipe make	
Butterfly valve make	
Gate/Check valves make	
Pot Strainer	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
Y-Strainer	
Mixing Valve	
Water Flow switch	
Blower Fan:	
S.No.	
Type	
Manufacturer	
CFM	
Static Pressure (mm WG)	
Motor HP	
Insulation Class	
Outlet Velocity (FPM)	
RPM	
Type of Drive	
Noise level (DB)	
Ventilation requirements:	
for DG set combustion	

DESCRIPTION	Details
Diesel Generating Set	750 & 320 kVA
for DG set ventilation to maintain 7OC rise in temperature over ambient	
Approvals from following shall be obtained by Contractor prior to commencement of work and after completion as required	
Chief Electrical Inspector to the Local State Government	
State Electricity Authorities/HERC /CEA	
Pollution Control Board for air and noise pollution	
Department of Explosives	
Noise Limit (Pollution Norms):	
Confirmation of compliance to noise limits stipulated in Central Government Notification dated July 9, 2002 to comply with Environment (Protection) Third Amendment Rules, 2002 or latest amendment in Pollution norms laid by Statutory Authority.	

D.G. SETS COST OF GENERATION:

DESCRIPTION	Unit	Details
		1010 KVA

DESCRIPTION	Unit	Details
		1010 KVA
Make of Engine		
Make of DG set		
Engine Model		
DG set rating	KVA	
DG Set rating	KW	
Average Load factor	%	
Units generated per hour	KWH/hour	
Number of hours per year	Hour annum	
Number of units generated per year	KWH/annum	
Fuel Cost:		
Fuel rate	Rs. Per litre	
Fuel consumption	Litres/hour	
Number of units per litre of Diesel	KWH/litre	
Fuel Cost:	Rs. Per KWH	
Lub Oil Consumption Cost:		
Lub oil consumption	Litres/hour	
Cost of lub oil	Rs. Per litre	
Lub oil consumption cost	Rs. Per hour	
Lub Oil Consumption cost	Rs. Per KWH	

DESCRIPTION	Unit	Details
		1010 KVA
Lub Oil Replacement Cost	Rs. Per litre	
Lub Oil replacement period	Hours	
Lub Oil replacement quantity	Litres	
Lub Oil replacement	Litres/hour	
Lub Oil replacement cost	Rs./hour	
Lub Oil replacement Cost	Rs. Per KWH	
Maintenance Cost		
‘B Check” maintenance period	Hours	
‘B Check” maintenance kit cost	Rs.	
‘B Check” maintenance cost	Rs. Per KWH	
‘C Check” maintenance period	Hours	
‘C Check” maintenance kit cost	Rs.	
‘C Check” maintenance cost	Rs. Per KWH	
‘D Check” maintenance period	Hours	
‘D Check” maintenance kit cost	Rs.	
‘D Check” maintenance cost	Rs. Per KWH	
Air Cleaner element change period	Hours	
Air cleaner Element cost	Rs.	
Air Cleaner Element replacement cost	Rs. Per KWH	

DESCRIPTION	Unit	Details
		1010 KVA
Total Cost per KWH generated		

DG SETS – EMISSION LEVELS – at 100% load

ITEM	Emission level as per Pollution Control Board Norms	Guaranteed emission level of the engine offered to be provided		
Nox	9.2 g/kW-Hr			
SOx				
CO	3.5 g/kW-Hr			
HC	1.3 g/kW-Hr			
Dust (particulate matter)	0.3 g/kW-Hr			

SPECIAL INSTRUCTIONS TO TENDERERS

Compatibility & Coordination with PLC

A microprocessor based PLC panel for Automatic Mains Failure, Auto Changeover/ Interlocking and Auto Load Sharing, Auto Load Management and auto synchronizing functions of the DG sets is incorporated with the Main LT Panel of the system being provided through the electrical contractor to be appointed by the Owners. Control cabling between the DG sets and the PLC is to be done under this contract. All parts of the DG set installation covered by this contract shall be compatible for being integrated with the PLC operation. The DG Contractor shall coordinate his work with that of electrical Contractor for achieving a fully coordinated and trouble free operation of the DG sets and their sub-systems through the PLC panel.

Completeness of contract

The Contractors shall undertake the complete installation and shall be responsible for the overall satisfactory operation of the DG sets with the associated accessories. The tenderer shall confirm as part of the tender that the associated equipments are suitable for the DG sets and the total system shall be compatible in all respects.

Quoted rates

Quoted rates shall be deemed to be inclusive of the cost (but not limited to) of the following.

All equipments described hereafter shall be in accordance with the specifications.

All equipments shall be selected and installed for the lowest operating noise level.

Supply of various equipments shall include cost of correspondence with manufacturers, submission of shop drawings and documents and their approval by the Consulting Engineer, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipments at site of installation, furnishing all technical literature required, replacement of defective components and warranty obligations for the individual equipment.

Statutory approvals from all concerned authorities (State Electricity Authority, HERC, Pollution Control Board, Department of Explosive etc.)

Installation of various equipments shall include all material and labour associated with hoisting and lowering of equipment in position, insulation of the components where ever required, vibration isolation as required, grouting and anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer's recommendation.

Vibration isolators shall be installed with components as required. Performance ratings, power consumption and sound power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

Testing and commissioning shall include furnishing all labour, materials, equipment, instruments, fuel oil and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations, submission of test results to the Project In-charge and obtaining their approval and submission of necessary documents and completion drawings.

All piping shall be installed conforming to the relevant Indian standards, approved shop drawings and shall be tested as per Standards.

Fuel piping and installation shall be as per the requirement of Department of Explosive. Quoted rate shall include cost of radiographic tests of welded joints randomly selected by Project In-charge in addition to hydrostatic pressure testing.

Piping installation shall include all costs toward supplying and fixing pipes and fittings (elbows, tees, reducers) cutting, threading, joining, welding, soldering and effecting connection as required; providing non hardening sealing material as well as neoprene rubber gaskets for screwed flanges, providing and installing adequate number of clamps, hangers, saddles, brackets, rawl plugs and other accessories for pipe supports, providing minor dressing of walls and floor, providing and installing pipe sleeves etc. as required.

Exposed steel pipes shall be given two coats of approved paint as per the relevant Indian standards for color coding of pipes and direction of flow of fluid in the pipes shall be visibly marked with identifying arrows.

All buried pipes shall be wrapped with 4 mm thick wrapping as per manufacturer's standards.

Valves, unions, strainers, drain and air valves, expansion joints, pressure gauges and thermometers shall be provided in the various pipe lines as per the approved shop drawings and specifications.

After completion of the installation, the entire piping system shall be tested for leakage as required.

ENERGY METERS.

FOR HT INCOMERS

Power Quality Analyser - High end power quality analyser with Class 0.2 active energy Accuracy with Sag/Swell - Waveform capture and Individual harmonics monitoring upto 63rd. Power Quality analyser needs to be capable of Disturbance direction detection with onboard dual ethernet Port communication.	
Basic Parameters	Current, voltage, frequency Active, reactive, apparent power Total and per phase Power factor Total and per phase Current measurement range (autoranging) 0.05 - 10A
Energy Parameters	Active, reactive, apparent energy Settable accumulation modes
Demand Parameters	Current Present and max. values Active, reactive, apparent power - Present and max. values Predicted active, reactive, apparent power Synchronisation of the measurement window Setting of calculation mode - Block/ sliding
Power Quality Parameters	Total Harmonic distortion Current and voltage Individual harmonics - Upto 63rd Waveform capture Detection of voltage swells and sags Disturbance Direction detection

Sampling Rate / Cycle	Minimum 256 Samples/ Cycle
Data Recording	512MB of standard non-volatile memory. 10 MB of standard non-volatile memory dedicated to capture billing data, events, and waveforms.Logs of Min/max of instantaneous values, Event logs, Trending/ forecasting, SER (Sequence of event recording).
Class Accuracy	Active Energy - Class 0.2S IEC 62053-22 , Reactive Energy Class - 0.5S IEC 62053-24, Power Factor - Class 0.5 as per IEC 61557-12
PQ Standards	PQ compliance reporting as per IEC 61000-4-30 Class S, - IEC 62586 PQI-S
Communication	Onboard Dual ethernet port for daisy chaining over ethernet. Meters need to have Modbus Mastering capability by connecting Slave devices over RS485 port
Time Synchronisation	GPS clock (RS485) or IRIG-B (digital input) to +/- 1 millisecond.
Digital IO	Standard: 3 digital status inputs for Breaker ON/OFF/Trip monitoring & 1 KY (form A) energy pulse output for interfacing with other systems. Expandable DI/DO, ADI/ADO capability
Display	Bright LCD colour display with meter dimension 96 X 96 mm only

FOR LT PANEL AND OTHERS

Multifunction Meter - Multifunction meters with Power and harmonics monitoring capturing abnormalities in the system with date and time stamp	
Basic Parameters	Current - Average line current of 3-phase, per-phase, and calculatedneutral current Voltage Average voltage of L-L, L-Nparameters, and per-phase Frequency Displacement power factor Average and per-phase signed True power factor Average and per-phase signed % unbalance among the phase for I, V L-N, V L-L
Energy & Power Parameters	Real, reactive, and apparent power Total and per-phase value Accumulated Active, Reactive and Apparent Energy, Received and Delivered registers, Net and absolute energy values, time counters

Demand Parameters	Current average, Active power, Reactive power, Apparent power - Present, Last, Predicted, Peak, and Peak Date Time Demand sync methods Thermal, Timed, Command Sync, and Clocked Sync Demand calculation mode Sliding, fixed and rolling block Demand intervals - settable from 1 to 60 minutes
Power Quality Parameters	THD as per IEC 61557-12 for THD and individual harmonics up to 15th over communication
Sampling Rate / Cycle	Minimum 64 Samples / Cycle
Class Accuracy	Active energy - Class 0.5S as per IEC 62053-22
Communication	RS 485 port Modbus RTU and disabling RS485 port against unauthorized access.
Calibration LED	configurable from 1 to 9999000 pulses/k_h (kWh, kVAh, or kVARh)
Min/Max values	instantaneous parameters with timestamp
Display	Bright red colour LED display with meter dimension 96 X 96 mm only

14.0 INTELLIGENT ADDRESSABLE FIRE ALARM AND DIGITAL EVACUATION SYSTEM

14.1 GENERAL DESCRIPTION

A. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

B. The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system wide or in selected zones.

C. The system shall support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.

D. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a communication network.

14.2 SCOPE

A. A new intelligent reporting, microprocessor controlled fire and gas detection system shall be installed in accordance to the project specifications and drawings.

B. Basic Performance:

Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Class A Signalling Line Circuits (SLC).

Device Circuits (IDC) shall be wired NFPA Class A as part of an addressable device connected by the SLC Circuit.

Notification Appliance Circuits (NAC) shall be wired NFPA Class A as part of an addressable device connected by the SLC Circuit.

On Class A configurations a single ground fault or open circuit on the system Signalling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone which ever is greater. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions. NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.

Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone.

Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.

Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B, or two Class A circuits.

Digital amplifiers shall be capable of storing up to two minutes of digitally recorded audio messages and tones. The digital amplifiers shall also be capable of supervising the connection to the associated digital message generator, and upon loss of that connection shall be capable of one of the following system responses:

The digital amplifier shall automatically broadcast the stored audio message.

The digital amplifier shall switch to a mode where a local bus input on the digital amplifier will accept an input to initiate a broadcast of the stored message. This bus input shall be connected to a NAC on a local FACP for the purpose of providing an alternate means of initiating an emergency message during a communication fault condition.

Speaker circuits shall be either 25 VRMS or 70VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.

Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Center and up to thirty five (35) remote Fire Fighter's Telephone locations simultaneously on a conference.

Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.

The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of up to 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.

The proposed product shall not restrict the buyer to one single organization, not shall it require any proprietary dongle or other programming tools for after sales & maintenance activity.

The MTBF for the product offered shall be less than 40

14.3 DRAWINGS & TECHNICAL SUBMITTALS

14.3.1 General

Two copies of all submittals shall be submitted to the Engineer-in-Charge/Consultant for review.

All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

14.3.2 Shop Drawings

Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

Show annunciator layout, configurations, and terminations.

14.3.3 Manuals

Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.

Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.

Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

14.3.4 Software Modifications

Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.

Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

14.3.5 Certifications

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

14.4 WARRANTY : The fire alarm control panel, voice panels and any head-end equipment shall have a manufacturer’s warranty of a minimum of 12 months.

14.5 APPLICABLE STANDARDS AND SPECIFICATIONS

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable or relevant IS Codes.

NFPA 12	Extinguishing Systems (low and high)
NFPA 12A	Halon 1301 Extinguishing Systems
NFPA 13	Sprinkler Systems

NFPA 15	Water Spray Systems
NFPA 16	Foam / Water Deluge and Spray Systems
NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 2001	Clean Agent Extinguishing Systems
NFPA 70	National Electric Code
NFPA 90A	Air Conditioning Systems
NFPA 92A	Smoke Control Systems
NFPA 92B	Smoke Management Systems in Malls, Atria, Large Areas
NFPA 72	National Fire Alarm Code
NFPA 101	Life Safety Code

UL 268	Smoke Detectors for Fire Protective Signalling Systems
UL 864	Control Units for Fire Protective Signalling Systems
UL 2572	Mass Notification Systems
UL 217	Smoke Detectors, Single and Multiple Station
UL 228	Door Closers - Holders for Fire Protective Signalling Systems
UL 268A	Smoke Detectors for Duct Applications
UL 521	Heat Detectors for Fire Protective Signalling Systems
UL 464	Audible Signalling Appliances
UL 38	Manually Actuated Signalling Boxes
UL 1481	Power Supplies for Fire Protective Signalling Systems

UL 346	Waterflow Indicators for Fire Protective Signalling Systems
UL 1076	Control Units for Burglar Alarm Proprietary Protective Signalling Systems
UL 1971	Visual Notification Appliances
UL 2017	Standard for General-Purpose Signalling Devices and Systems
UL60950	Safety of Information Technology Equipment

The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of low pressure CO2.

The system shall be certified for seismic applications in accordance with the International Building Code (IBC) / NBC. The basis for qualification of seismic approval shall be via shake table testing.

The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the 4-20 monitor module and industry standard 4-20 mA gas detectors.

14.6 DESIGN INTENT

Main fire alarm panel with digital voice command system, Fire fighters telephone, amplifier, zone selector keypad and announcement console – Ground floor – Near passenger lift lobby.

Secondary fire alarm panels- At each level – near lift lobby

Active repeater panels at security cabin

All fire alarm panels connected as pier to pier.

Fire survival cables (750 deg. 2 hours)

Class - A cabling to loop all detectors, devices & MCP‟s to control panel.

Coverage per detector as per NFPA -2015, considering > 60 ACH

System integration (Soft integration) with all standalone panels such as agent release panels for deluge valves, Pre-action panels, lift switchboard, DG fresh air switchboard, etc

VESDA (Very Early Smoke Detection Apparatus) to cover the false flooring and room void areas of Data Hall, UPS, Battery rooms and MMR.

Emergency communication system, integral with the Main FACP, including voice alarm system components, microphones, amplifiers, zone selector keypads and tone generators

Audible Alarm Notifications

Fire fighters telephone system as part of main fire alarm system which is two-way, supervised voice communication proposed to link between the MFACP and remote fire fighters' telephone stations throughout the building (at all staircases at all levels)

14.7 DETAILED DESCRIPTION OF THE SYSTEM COMPONENTS:

14.7.1 BASIS OF DESIGN

An Intelligent Modular/ Expandable Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the building.

The system shall be provided with Addressable fire alarm initiating, annunciating and control devices.

The addressable and intelligent system shall be such that smoke sensors, thermal sensors, manual call points, etc., can be identified with point address.

The FAS shall be able to recognize normal and alarm conditions, below normal sensor values that reveal trouble condition, and above normal values that indicate either an alarm condition or the need of maintenance.

Read-out or address an actual detector location. The operator shall also be able to adjust alarm and alarm thresholds and other parameters for the smoke sensors.

Provide a maintenance/pre-alert/fault alarm capability at smoke sensors to prevent the detectors from indicating a false alarm due to dust, dirt etc.

Provide alarm verification of individual smoke sensors. Systems that perform alarm verification on a zone basis shall not be acceptable. Alarm verification shall be printed on the printer at the Control Station's printer to enhance system maintenance and identify possible problem areas.

Provide local numeric point address and LED display of device and current condition of the point.

Each detector shall use state-of-the-art Microprocessor Circuitry with error, detector self-diagnostics and supervision programs.

The detection of the fire shall be taken at the detector level.

Multi-Criteria Detectors shall be offered where by the system logic activation is based on any three inputs from the detector i.e. smoke, fixed heat or rate of rise heat.

Provide outputs that are addressable, i.e. outputs shall have point address. The operator shall be able to command such points manually or assign the points to Logical Point Groups (Software Zones) for pre-programmed operation.

In the event of a fire alarm, but not in a fault condition, the following action shall be performed automatically.

The System Alarm LED on the main fire alarm control panel shall flash.

A local sounder shall be sounded.

The LCD display on the main fire alarm control panel shall indicate all information associated with Fire Alarm condition including the type of alarm point and its location within the premises.

Printing and history storage equipment shall log the information associated with the Fire Alarm Control Panel condition, along with the time and date of occurrence.

All system output programs assigned via control-by-event programs that are to be activated by a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

14.8 SYSTEM COMPONENTS AND DEVICES:

14.8.1 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:

Main FACP or network node shall contain a microprocessor based Central Processing Unit (CPU) and power supply. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

Supervise all initiating signalling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.

Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

14.8.2 System Capacity and General Operation

The FACP shall can communicate on a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 panels / nodes per network.

The control panel shall be capable of expansion via up to 10 SLC loops. Each module shall support up to 300 analog/addressable devices for a maximum system capacity of 3000 points.The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 600-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric QWERTY keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either come owner or installing company.

All programming or editing of thmming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

14.9 The FACP shall be able to provide the following software and hardware features:

Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.

Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.

The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.

NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the sensitivity testing requirements of NFPA 72.

Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop. A single change to one CPU database shall not require a database download to other CPUs.

History Events: The panel shall maintain a history file of atleast last 5000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 5000 event history file.

Smoke Control Modes: The system shall provide means to perform Fire Smoke Control Station mode. This mode controls all dampers, smoke extraction fan, fresh air supply fans, etc during Fire condition. Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.

The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.

Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions

Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.

Multi-Cooperating Detectors: The system shall provide means to link one detector with up to two detectors at other addresses in cooperative multi-detector sensing. The detector shall take feedback from the other two adjacent detectors to take fast and genuine alarm decision mitigating the risk of false alarm. There shall be no requirement for mandatory sequential address setting in the detectors to achieve this function. Multi-cooperative detection shall be a built-in intelligence in the system to take fast & reliable decision on genuine alarm triggering. The alarm event shall be a result of all cooperating detector chamber readings considered as a consolidated alarm signal.

ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.

Security Monitor Points: The system shall provide means to monitor any point as a type security.

One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as Control By Event and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

Control by Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

100 trouble equations per device: The system shall provide support for up to 100 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.

Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period.

Secure/Access Operation: The system shall have the capability of configuring input modules to monitor status of door contact or other security type sensors. These input modules shall be able to be commanded from the normally ‘Secure’ state to an ‘Access’ state. While in the secure state, the module will transmit alarm conditions to the controller, which shall be annunciated on the LCD and LED displays. The modules shall be placed into the Access state either through the LCD display or through predefined operator keys. While in the Access state, all alarms from the module will be shunted. Placing the module into the access state shall cause a discrete LED associated with input point to flash, but no other trouble or disable condition will be annunciated. Change from Secure to Access and reverse shall be transmitted to the central monitoring station on a per zone basis. Systems that cause or indicate a trouble or disable condition are unacceptable.

14.10 The FACP shall be capable of communicating with a Distributed Control System

Central Processing Unit

The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.

The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

The CPU shall provide an RS-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.

The CPU shall provide two RS-485 ports for the serial connection to annunciation and control subsystem components.

The RS-232 serial output circuit shall be optically isolated to assure protection from earth ground.

In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Systems not offering degrade mode shall offer Redundant CPU. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

14.11 Display

The system display shall provide a 600-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide eleven Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, CONTROLS ACTIVE, and CPU FAILURE.

These characters shall be only for fire alarm / trouble information and not for Logo or other purpose. It shall be UL Listed. Repeater panel displays in FACP is not allowed unless until approved by UL

The system display shall provide a QWERTY style keypad for ease of operation.

The keypad shall have control capability to command all system functions, entry of any alphabetic or numeric information, and field programming without the use of any external equipment or laptop. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

14.12 Loop (Signalling Line Circuit) Control Module:

The control panel shall be capable of expansion via up to 10 SLC loops. Each module shall support up to 300 analog/addressable devices for a maximum system capacity of 3000 points.

The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

Each loop shall maintain 20% spare capacity for future expansion.

Each Loop shall be capable of operating as a NFPA Class B circuit in case of single open circuit fault in existing SLC CircuitFault isolation modules shall be installed between each addressable SLC device per the manufacturer's installation instructions. Systems which cannot provide full loop loading in Style 7 configurations are not acceptable.

The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to

automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

14.13 Network Communication

The FACP shall communicate over a peer-to-peer communication network, inherently over a regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 Control Panels / Network Nodes, over a single medium (copper conductor / fiber optic), redundant ring, and communication channel for fire alarm, voice evacuation and telephone talk-back system. The system shall support up to 200 such networks in a single system.

The network card shall have inbuilt Fiber port for terminating Fiber Optic Cable without any third party converters.

14.13.1 Digital Voice Command Center

The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signalling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.

Function: The Voice Command Center equipment shall perform the following functions:

Operate as a supervised multi-channel emergency voice communication system.

Operate as a two-way emergency telephone system control center.

Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.

Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.

Provide all-call Emergency Paging activities through activation of a single control switch.

As required, provide vectored paging control to specific audio zones via dedicated control switches.

Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.

Provide a software utility capable of off-line programming for the DVC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the DVC shall not inhibit the emergency operation of other nodes on the fire alarm network.

Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SLC controlled switching.

The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.

The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

Fire, Voice & Telephone data shall flow through single network cable.

The Voice Evacuation System shall be capable of establishing communication between the master voice controller and amplifier over fiber optic cable network without using any third party media converter.

Failure of Fire Panel CPU shall not affect the operation of DVC. Incase DVC / Amplifiers are controlled by Fire Panel CPU, a separate panel with dedicated CPU shall be considered for each DVC & Amplifier.

14.14 Power Supply

The Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.

The Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.

The Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.

The Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

The Main Power Supply shall be power-limited per UL864 requirements.

The Main Power Supply shall communicate power supply, line voltage, battery status and charger status to the local LCD display. Any abnormal condition shall be annunciated and logged to the system alarm history log.

The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signalling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.

The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.

The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.

The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.

The addressable power supply mounts in either the FACP backbox or it's own dedicated surface mounted backbox with cover.

Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.

The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.

When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.

The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

14.15 Audio Amplifiers

The Audio Amplifiers shall provide Audio Power @ 25 Volts RMS@70 Volts RMSfor distributions to speaker circuits.

Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).

The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:

Earth Fault Detection & Annunciation for Communication bus

Audio Amplifier Failure Trouble Annunciation

External trigger input indication in case of Amplifier failure

Audio Detected on Firefighter's Telephone Riser

Receiving Audio from digital audio riser

Short circuit on detection & annunciation on each speaker circuit

Communication Status

Board failure

Active fiber optic media connection

Power supply monitoring of below conditions – Earth fault, Low Battery, Charger Trouble

Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.

Include audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).

System shall be capable of backing up digital amplifiers.

One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.

Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.

System shall support distributed Engineer-in-Chargeure of voice evacuation system to enable remote installation of amplifiers. Remote Amplifier’s shall communicate with the centrally located Digital Voice Command.

14.16 Controls with associated LED Indicators

Speaker Switches/Indicators

The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.

The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

Emergency Two-Way Telephone Control Switches/Indicators

The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.

The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

14.17 Field Programming

The system shall be programmable, configurable and expandable in the field without the need for special tools. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.

It shall be possible to program through the standard FACP keyboard all system functions.All field defined programs shall be stored in non-volatile memory.Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second

(higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password. The system programming shall be "backed" up via an upload/download program, and stored on compatible removable media. A system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

14.18 Specific System Operations

Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.

Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

14.19 System Point Operations

Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or Graphics User Interface.

System output points shall be capable of being turned on or off from the system keypad or the video terminal.

Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

Device Status.

Device Type.

Custom Device Label.

Software Zone Label.

Device Zone Assignments.

Analog Detector Sensitivity.

All Program Parameters.

System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 5000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.

The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

System Maintenance Analysis and Reporting

The system shall automatically track NFPA 72 installation and testing requirements for all addressable devices to ensure that every device is functionally tested upon installation and then periodically as required by the Code.

If after twelve months any device has not been functionally tested a led shall illuminate on the CPU or Network annunciator indicating the device that needs testing.

The system shall automatically track device testing to ensure that a visual inspection is performed at least semi-annually.

If after six months a device has not been indicated as "visually inspected" a led shall illuminate on the CPU or Network annunciator indicating the device that needs testing.

A hand-held IR tool may be used to interact with each SLC device to indicate that a visual inspection has been performed. The IR device will explicitly identify the device by loop and address to ensure the correct visual inspection has been performed.

A comprehensive report shall be available from the laptop programmer which shows a predictive report of all devices that have upcoming testing requirements. These reports shall be configurable as either 30, 60 or 90 day predictive, current status, and "all database."

Systems that do not automatically track the individual testing requirements of the field devices will not be accepted.

14.20 SYSTEM COMPONENTS

14.20.1 Network Control Annunciator

A network control annunciator shall be provided to display all system intelligent points. The NCA shall be capable of displaying all information for 200,000 points on the network. Network display devices, which are only capable of displaying a subset of network points, shall not be suitable substitutes.

The NCA shall include a minimum of 600 characters, backlit by a long life, solid state LCD display. It shall also include a full QWERTY style keypad with tactile feel. Additionally, the network display shall include ten soft-keys for screen navigation and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

The network control annunciator shall have the ability to display up to eight events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

The NCA shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a backbox designed for this useand shall connect to the network over either a wire or fiber interface.

The network control annunciator shall have an event history buffer capable of storing a minimum of 1000 events in non-volatile memory. Additionally, the NCA shall have a fire alarm history buffer capable of storing a minimum of 200 events in non-volatile memory. Systems that do not protect fire alarm events from being overwritten by other events are not suitable substitutes.

The NCA shall include two optically isolated, 9600 baud, industry standard RS-232 ports for UL864 listed printers and CRT's. These peripheral devices shall print or display network activity.

The network control annunciator shall include control switches for system wide control of Acknowledge, Signal Silence, System Reset, Drill, and local Lamp Test. A mechanical means by which the controls switches are "locked out", such as a key, shall be available.

The NCA shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The NCA shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

The network control annunciator shall support an optional WindowsTM based program utility. This utility shall allow the user create an NCA database, upload/download an NCA database, and download an upgrade to the NCA executive. To ensure program validity, this utility shall check stored databases for errors. A compare function shall be included to identify differences between databases.

For time keeping purposes the NCA shall include a time of day clock.

14.20.2 Network Control Station / Graphics User Interface

The NCS shall utilize a Microsoft(tm) operating system. Each Network Control Station shall be capable of graphically annunciating and controlling all network activity and at least 2,50,000 network points. Network display devices that are only capable of displaying a subset of network points shall not be suitable substitutes.

The NCS shall be an IBM (or compatible) personal computer with the following minimum requirements: Intel Pentium II(tm)-processor, operating at a minimum of 400 Mhz, 128Mbytes of RAM, 8 Mbytes Video RAM, 1.44 Mbyte floppy drive, 3.2 Gbyte hard disk, mouse, 32X CD-ROM, 3PCI / 1 ISA expansion slots, internal 3.2 Gbyte tape drive, sound card, 200 watt power supply, and SVGA graphics with a screen resolution of 1024 x 768. The network control station shall include a 19-inch monitor.

The NCS shall be capable of storing over 100,000 network events in a history file. Events shall be stored on hard disk and shall be capable of back-up storage to a tape drive. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out. The ability to print NCS history files shall also be available.

The NCS shall use a Windows(tm) dialog box technology to address, interrogate, control, and/or modify intelligent points on each fire alarm node. This shall include, and not be limited to: Activating outputs, enabling or disabling points, adding or removing intelligent points, viewing intelligent detector sensitivity levels and modifying point information (custom messages, detector type, verification, day/night selection etc.)

The NCS shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device. The NCS shall also provide the ability to auto-vector to the floor plan (screen) of the device that is active. By selecting a device in the graphic presentation, the operator of the NCS shall have the ability to log onto the corresponding node and interrogate the associated intelligent point.

The NCS shall have the ability to provide the following information through a Windows(tm) pull down menu: An Event Counter that contains the number of new and total events on the network. The information that is displayed shall consist of Fire Alarms, Pre-Alarms, Security Alarms, Supervisory Alarms, and Troubles. A Detailed Event window that contains all Off-Normal events, both unacknowledged and acknowledged that are present in the system. It shall contain two views, Fire events and Non-fire events that shall be user selectable. A Current Event window that shall contain all network and local events as well as system messages with a maximum of 1,000 events displayed. A Disabled Device window that shall contain all disabled devices in the system.

The NCS shall have the option, from a Windows pull down menu, to connect to a third party paging service that allows the NCS to automatically send text-based messages regarding system status to a typical text pager.

The NCS shall include help screens, available to aid the user without leaving the selected application screen. The NCS shall be UL-Listed for fire protection (UL864) and burglary (UL1076). The NCS shall interface with other panels as a node in the pear to pear network.

The operator shall be able to monitor the FFT system from GUI software and shall be able to monitor and control Integrated Voice Evacuation System.

The NCS shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high level "administrator" who shall have complete control over levels of control. If no action has taken place on the NCS after 10 minutes, the current operator shall be logged out and require a new log-in. The NCS shall include an industry-standard RS-232 port for a UL864 listed printer. The NCS shall be a table top hardware configuration.

14.20.3 Interactive Firefighters' Touchscreen Display

The network will interface and report the individually monitored system's alarm status via a user-friendly Graphical User Interface (GUI) based software.

The software shall operate under Microsoft Windows XP Embedded platform as manufactured by Microsoft Corporation.

The GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations. It shall be capable of mapping at least 2,50,000 network points

The software shall use a 1280 pixel x 1024 pixel GUI display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.

The software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.

The fire alarm device icon shall be visible only when it is in an alarm (or active) condition.

The software shall display the activated smoke detectors in a time sequence to track smoke progression.

The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.

The software shall provide a intuitive and easy way to navigate to different screens representing floors and areas within a facility.

The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.

The software shall display "YOU ARE HERE" along with icons representing standard building objects (stairs, elevators, etc) to be shown on the floor plan.

The software shall allow icons that represent hazardous materials stored in a facility.

The software shall provide a screen that displays preprogrammed building contact information.

The software shall provide a screen the displays building occupancy and other general building information.

The software shall allow a site plan to be imported that shows an aerial view of the facility.

The software shall display all active fire, supervisory, and security events within an event list.

14.21 GATEWAY AND WEB SERVERS

BACnet Interface Gateway: The system shall be capable of being interfaced with BACNet compliant NBCCs. A BACnet interface supporting BACnet/IP communication shall be available from the fire alarm control panel manufacturer.BACnet shall support 14000 data points. BACnet gateway shall communicate with all the panels in a peer to peer network.

MODbus Interface Gateway: The system shall be capable of being interfaced with MODbus compliant NBCCs. A MODbus interface supporting MODbus/TCP communication shall be available from the fire alarm control panel manufacturer. MODbus shall support 22500 data points. MODbus gateway shall communicate with all the panels in a peer to peer network.

Webserver: The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the webserver shall be available from the fire alarm control panel manufacturer.

Web Portal Interface: The system shall be capable of being interfaced with a web portal to integrate with Inspection and Service Manager Utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

14.22 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

14.22.1 Addressable Devices – General

Addressable devices shall provide an address-setting means using rotary decimal switches. Addressable devices that require the address be programmed using a programming utility are not an allowable substitute. Addressable devices shall use simple to install and maintain decade, decimal address switches.

Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.

Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signalling Line Circuits.

Addressable smoke and thermal detectors shall provide dual alarm and power/polling bi-colour LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).

Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

14.22.2 Addressable Manual Call Point (Break Glass / Pull Down Type)

Addressable manual call point shall send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

Manual fire alarm boxes shall be constructed of Lexan / ABS Plastic with clearly visible operating instructions provided on the cover. The word FIRE / Fire Sign shall appear on the front of the stations.

14.22.3 Intelligent Photoelectric Smoke Detector:

The intelligent photoelectric smoke detector shall shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

14.22.4 Intelligent High Sensitivity Photo Smoke Detector

The intelligent high sensitivity photo smoke detector shall be a spot type detector that incorporates an extremely bright high sensitivity diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

The high sensitivity detector shall have conductive plastic so that dust accumulation is reduced significantly.

The intelligent high sensitivity photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.

The high sensitivity detector shall not require expensive conduit, special fittings or PVC pipe.

The intelligent high sensitivity photo detector shall support standard, relay, isolator and sounder detector bases.

The high sensitivity photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.

The high sensitivity photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

14.22.5 Intelligent Multi Criteria Detector

The intelligent multi-criteria detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settingsfor early detection and reduction in false alarm. The detector design shall allow a wide sensitivity window, 0.5 to 2.5% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

14.22.6 Intelligent Thermal Detectors

The intelligent thermal detectors shall be addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. A high heat thermal detector rated at 190 degrees Fahrenheit (87.8 degrees Celsius) shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signalling line circuit.

14.22.7 Intelligent Duct Smoke Detector

The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable or being tested remotely.

14.22.8 Advanced Multi-Criteria Intelligent Fire/CO Detector

Advanced Multi-Criteria Fire/CO detector be an addressable advanced multi-criteria smoke detector with a separate signal for carbon monoxide (CO) detection per UL 2075 standards.

The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.

The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.

The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.

The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20 percent of the drift range is remaining, when 100 percent of drift range is used, and when there is a chamber fault to show the unit requires maintenance.

The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self-test failure, IR self-test failure, and freeze warning.

The detector shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detector shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 159 possible addresses on the signalling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.

The detector shall provide a test means whereby it will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There shall be four test methods: functional magnet, smoke entry aerosol, carbon monoxide aerosol or direct heat method.

The detector shall provide two LEDs to provide 360° visibility. The LEDs shall be placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector must be capable of connecting to a sounder base that provides both temporal 3 and temporal 4 patterns for fire and CO alarm.

Two LEDs on the sensor shall be controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, shall cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.

The detector shall be plug-in mounted into a twist-lock base. The detector shall be constructed of off-white, UV-resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. The mounting base shall be mounted on a junction box that is at least 1.5 inches (3.81 cm) deep. The mounting base shall be available to mount to standard junction boxes. Suitable boxes include:

4.0" (10.16 cm) square box with and without plaster ring.

4.0" (10.16 cm) octagonal box.

3.5" (8.89 cm) octagonal box.

Single-gang box.

Double-gang box

Meets Agency Standards

ANSI/UL 268 -Smoke Detectors for Fire Alarm Signalling Systems

CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems

FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signalling

UL 2075 – Gas and Vapor Detector and Sensors – Systems Connected

14.22.9 Intelligent Addressable Aspiration Detector

The intelligent aspiration detector shall be an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high level interfaces shall be required. The fire alarm control panel shall support up to thirty one intelligent aspiration detectors per SLC loop. The aspiration detector shall have dual source (blue LED and infra-red laser) optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type ID at the FACP.

14.22.10 Intelligent Addressable Reflected Beam Detector

The intelligent single-ended reflected beam smoke detector shall connect with two wires to the fire alarm control panel signalling line circuit (SLC). The detectors shall consist of a transmitter/receiver unit and a reflector and shall send data to the panel representing the analog level of smoke density. The detector shall be capable of being tested remotely via a key switch; It shall be equipped with an integral sensitivity test feature.

The Beam Detectors shall be long range, projected beam type smoke detectors which consist of a Transmitter and receiver in a single unit and reflector on the other side.

The Beam Detector shall have a range upto 100 mtrs. There shall be multiple sensitivity levels. Starting from 25 %, 30 %, 40 %, 50 % and acclimate levels also 30 % to 50 % and 40 % to 50 %. There shall be trouble alarm if obscuration block is more than 96 %.

14.22.11 Addressable Dry Contact Monitor Module

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

The IDC zone shall be suitable for Class A or Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

14.22.12 Two Wire Detector Monitor Module

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device)

The IDC zone may be wired for Class A or B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

14.22.13 Addressable Control Module

Addressable control modules shall be provided to supervise and control the operation of one conventional circuit of compatible Notification Appliances, 24 VDC powered, polarized audio/visual notification appliances

The control module NAC may be wired for Class A/B with a current rating of 2 Amps

Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.

14.22.14 Addressable Releasing Control Module

An addressable releasing module shall be available to supervise and control compatible releasing agent solenoids

The module shall operate on a redundant protocol for added protection.

The module shall be configurable for Class A/B and support one 24 volt or two 12 volt solenoids.

14.22.15 Addressable 4-20 mA Module

Addressable 4-20 mA module shall be available to monitor industry-standard, linear-scale, 4-20 mA protocol sensors. The module converts the sensor output to communication protocol that can be interpreted by the FACP for monitoring and display

The module shall support programming of up to five programmable event thresholds.

The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the FMM-4-20 monitor module and industry standard 4-20 mA gas detectors.

14.22.16 Addressable Relay Module

Addressable Relay Modules shall be available for HVAC control and other network building functions

The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.

The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires;

For multiple relay control a module shall be available that provides 6 programmable Form-C relays.

14.22.17 Addressable Two-In / Two-Out Monitor/Relay Module

An addressable Two-In / Two-Out module shall be available.

The two-in/two-out module shall provide two Class B/Style B dry-contact input circuits and two independent Form-C relay srated at up to 3 Amps resistive and up to 2.0 Amps inductive.

14.22.18 Isolator Module

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

14.22.19 Serially Connected Annunciator

The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi-drop) two-wire communications loop. The system shall support two 6,000 ft. RS-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,000 points of annunciation.

An RS-485 repeater shall be available to extend the RS-485 wire distance in 3,000 ft. increments. The repeater shall be UL864 approved.

Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life programmable color LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.

The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.

Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.

An optional module shall be available to utilize annunciator points to drive RS-485 driven relays. This shall extend the system point capacity by 3,000 remote contacts.

The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

14.22.20 Speakers

The Speaker appliance shall be IS complaint or listed to UL 1480 for Fire Protective Signalling Systems. It shall be a dual-voltage transformer speaker capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.

A universal mounting plate shall be used for mounting ceiling and wall speaker products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate.

Speakers shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker design shall isolate speaker components to reduce ground fault incidents.

The speaker shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction.

All notification appliances shall be backward compatible.

14.22.21 Advance Speaker Strobes

The Speaker Strobe appliance shall be IS complaint or listed to UL 1971 and UL 1480 and be approved for fire protective signalling systems. It shall be a dual-voltage transformer speaker strobe capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.

A universal mounting plate shall be used for mounting ceiling and wall speaker strobe products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also, Advance speaker strobes shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels

with built in sync). 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts.

Speaker strobes shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker strobe design shall isolate speaker components to reduce ground fault incidents.

The speaker strobe shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12V or 24V. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12V and 15, 15/75, 30, 75, 110, or 115 when operating on 24V. The strobe shall comply with NFPA 72 and the Americans with Disabilities Act requirement for visible signalling appliances, flashing at 1 Hz over the strobe's entire operating voltage range.

All notification appliances shall be backward compatible.

Strobe lights shall meet the requirements of the ADA, UL Standard 1971and be fully synchronized.

14.22.22 Programmable Directional Sounders

Shall follow NFPA 72 2016 edition Clause A.18.4.7.1 recommendation.

Electronic sounders shall operate on 24 VDC nominal.

Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.

Shall be capable to broadcast preprogrammed Voice Message.

Shall be flush or surface mounted as shown on plans.

Shall produce broad band directional sound with 20 Hz to 20 Khz frequency band to guide occupants to safe exists even in complete darkness.

14.22.23 Addressable Portable Emergency Telephone Handset Jack

Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on plans. Handset jacks shall be approved for emergency telephone system application.

Insertion of a remote handset plug into a jack shall send a signal to the fire command center which shall audibly and visually indicate the on-line condition, and shall sound a ring indication in the handset.

The two-way emergency telephone system shall support thirty five (35) handsets on line without degradation of the signal.

Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.

14.22.24 Addressable Fixed Emergency Telephone Handset

The telephone cabinet shall be painted red and clearly labeled emergency telephone. The cabinets shall be located where shown on drawings.

The handset cradle shall have a switch connection such that lifting the handset off of the cradle shall send a signal to the fire command center which shall audibly and visually indicate its on-line (off-hook) condition.

The two-way emergency telephone system shall support thirty five (35) handsets on line (off hook) without degradation of the signal.

Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.

14.22.25 Batteries

The battery shall have sufficient capacity to power the fire alarm system for not less than 48 hours in standby plus 2 hours of alarm upon a normal AC power failure.

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

If necessary to meet standby requirements, external battery and charger systems may be used.

14.23 EXECUTION

14.23.1 INSTALLATION

Installation shall be in accordance with the IS / NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

14.23.2 CAUSE & EFFECT LOGIC

System shall be programmed as per the approved cause & effect logic.

14.23.3TESTING

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with IS / NFPA 72.

Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

Verify activation of all water flow switches.

Open initiating device circuits and verify that the trouble signal actuates.

Open and short signalling line circuits and verify that the trouble signal actuates.

Open and short notification appliance circuits and verify that trouble signal actuates.

Ground all circuits and verify response of trouble signals.

Check presence and audibility of tone at all alarm notification devices.

Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

Each of the alarm conditions that the system is required to detect shall be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

14.23.4 FINAL INSPECTION

At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

14.23.5 INSTRUCTION& TRAINING

Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

14.23.6 SUBMITTALS

Power calculations.

Battery capacity calculations.

Supervisory power requirements for all equipment.

Alarm power requirements for all equipment.

Justification showing power requirements of the system power supplies.

Voltage drop calculations for wiring runs in worst case condition.

Complete manufacturer's catalogue data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

Submit panel configuration and interconnection of modules and all other data as required to make an informed judgment regarding product suitability. As a minimum, data shall be submitted on the following:

Main system including all fire detection with main and secondary control panels. Circuit interface panels including all modules. Power supplies, batteries and battery chargers.

Equipment enclosures.

Intelligent addressable manual pull stations, multi-criterion detectors, heat detectors, analogue smoke detectors, alarm monitoring modules, and supervised control modules.

Audible and visual evacuation signals and devices.

Software and firmware as required providing a complete functioning system.

Wiring.

System driven remote annunciators. Interface module and wiring configuration from local system to Fire Command System.

Submit copies of UL listing or FM approval data showing compatibility of the proposed devices or appliances and the panels being provided.

Submit the following shop drawings.

Floor plans showing all initiating, end of line, supervisory, indicating appliances, and output control devices; including circuit interface panels, enunciators, printers, Control panel location.

Raceways, marked for size, conductor count with type and size

Calculations and mathematical justification for speakers meet the code required 15 dBA above ambient for audible warning signals.

Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.

Complete single-line riser diagram showing all equipment and the size type and number of all conductors.

Submit Method Statement for systems component wiring, installation, testing, commissioning and operating.

Typical installation drawings

Complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.

Guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for One years from date of completion Certificate.

15 PUBLIC ADDRESS SYSTEM:

15.1 GENERAL DESCRIPTION

The contractor shall supply, install, test, connect and commission a high quality fast-acting Public Address and Voice Alarm System complying strictly with BS 5839 part8 and EN60849. The technical design must comply with EN 54-4 for emergency power supply and with EN 54-16 for the VA/PA system. The Public Address and Voice Evacuation System shall comprise of Audio Matrix Units, High quality speakers, Audio rack all mounted on a 19" Rack and fully connected and integrated on the fire alarm loop. The system shall be used for Professional Sound Reproduction for all the areas where possible special events take place.

Prior to placing order for any equipment, the contractor shall submit comprehensive document comprising working drawings, catalogues and descriptive literature of components, acoustic calculation to meet with BS5839 part8 RASTI (Room Acoustic Speech Transmission Index) requirements of 0.5 on the STI scale and 0,7 on the CIS scale. The contractor shall be required to train and instruct IIFT / NBCC's personnel in the correct use, operation and supervision of the system, preferably prior to the handing over of the project.

In order to ensure whole site integration capability, the fire and voice alarm system will be awarded to a single specialist local supplier who will be responsible for the design, global operation, management and interfacing of the system. The contractor shall make sure that all power tapping of the speakers must be carried out as specified, even if the acoustic calculations indicates less power tapings. The contractor must endure minimum of 10dB above the ambient noise levels are achieved.

The system shall be fully programmed to accommodate fire alarm and voice communication zones as indicated on the drawings and schematics. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to the buildings.

15.2 APPLICABLE STANDARD:

EVAC Compliant with IEC/EN60849

Loudspeakers -Rated power IEC 60286-Part 5

Tested in accordance with BSEN60268-5

Acoustic models ready for CATT, ULYSSES & EASE

Compliant with BS5839 Part 8

Battery backup/charger compliant with EN54 part 4

15.3 SCOPE OF WORK

The Scope of work under this head shall include:

The scope of work under this head shall include designing supplying and installing of Public Address System. The work under this system shall consist of furnishing all materials, equipment's and appliances and labor necessary to install the said system, complete with Speakers, Amplifiers, Microphone, Zone Selection Panel for interfacing with other systems.

The PA system is designed to serve the dual purpose of making general announcement and Voice Evacuation at the time of Fire alarm activation.

15.4 SYSTEM DESIGN

For the transmission of alarm signals in the event of a fire or other disaster, as well as for public announcements and playing music, an emergency audio warning system or a voice alarm system with self-monitoring functionality and alarm criteria should be installed in compliance with VDE 0833-4 and DIN 33403 standards.

The purpose of the system is to quickly evacuate people in an orderly manner via escape routes through the use of prepared clear text instructions. In addition, it must also be possible to for all instructions that are announced live to be sent to circuits and groups.

There must be an intercom function between the digital call stations.

The failure of an amplifier or a loudspeaker circuit should not lead to the failure of a public address area. For this reason, in addition to the backup amplifier, the loudspeaker circuit also has A/B wiring in all public areas.

In total, up to 6,000 programmable, monitored loudspeaker circuits must be available as well as up to 2,000 NF inputs (250 x 4 x 2) or 1,000 digital call stations.

Due to simultaneous program transmissions, there must be up to 120 simultaneous audio transmissions within the VA/PA system.

It must be possible to assign inputs (including digital call stations) and outputs throughout the system without any restrictions.

A graphical user interface is used for simple and convenient configuration of the combination of groups, changes in loudspeaker circuits or key assignments without the need for any mechanical modifications.

When selecting the loudspeaker systems and rating the electrical and acoustic audio frequencies, the following sound pressure levels are used:

90 dB in larger public areas and

for fire alarm/evacuation announcements, at least 12 dB higher than the maximum anticipated ambient noise with speech intelligibility STI > 0.5.

Loudness level and speech intelligibility must correspond to all the points of the above areas where required (e.g. in the event of an alarm or rescue operation) for evacuation purposes and transmission of information.

The public address system must be designed in accordance with the following basic requirements:

Provision of direct sound to widest possible area +/- 3 dB of the relevant ranges

High level of system reliability (at least 99% availability)

Optimal transmission quality

A fully digital, programmable, network-ready VA/PA system must be provided to ensure that the system is future-proof, flexible, and can be easily extended.

A 100 Mbit Ethernet LAN, also for proprietary use, serves as a means of transmitting signals.

It must be possible to design a redundant network by means of external modules.

It is particularly important that 100 V lines, power cords, control and modulation lines are properly isolated.

Amplifiers must have symmetrically audio inputs.

The VA/PA system must fulfill the following requirements:

Fully digital network-capable system with graphical user interface. Operating software for remote control and diagnosis of all systems states. Software for optional setup (configuration) of functions, modes and properties of system components, devices and controls including the connection of loudspeaker lines to public address areas, and the corresponding allocation of a selection key at the system digital call station;

The user can modify the configuration using any NBCC with an easy-to-understand, menu-driven user interface. Up to 120 simultaneous audio channels must be available over the network with an available bandwidth of 100Mbit/s effective.

Continuous, inaudible monitoring of all signal paths

All errors must be detected, displayed, and recorded (log view) within a matter of seconds.

Ability to easily program digital call stations for selective, group and collective calls (e.g. 1 fire control PA panel, 3 information call stations, more possible at any time).

Continuous monitoring of power amplifiers with integrated noise detection and inaudible tone. If a power amplifier should fail, a backup amplifier will automatically and immediately replace the power amplifier in question.

Double pole connection of 100 V loudspeaker modulation;

Continuous processor - controlled line monitoring of all loudspeaker lines for short circuits, idling, ground faults and impedance value errors, independent of activated announcements. Monitoring must not be audible. Save error messages with the option for subsequent display; save set points ofline parameters; Set up and interrogate system with easy-to-understand, menu-driven software. Non-reactive disconnection of loudspeaker circuits detected to be faulty without any consequence to any other speaker lines.

To ensure continuous operation, the gooseneck microphone for the digital call station must be acoustically monitored. Similarly, the malfunction of any button, component, cable, or any logical connection must be monitored and sent to the operating unit immediately via the LAN. The signal is transmitted between the digital call station and the central control unit in AHO/EBU digital audio format.

Intercom function between digital call stations.

To adjust the volume in public address areas with constantly changing noise levels, an automatic volume control must always be available in real time, independent of the ambient noise level. This function is activated using software tools from the appropriate central output modules for this area.

Digital storage and playback of at least 16 different alarm signals and texts for 260 seconds in non-volatile memory.

Input of external signal sources (independent programs/background music) in the VA/PA system via separate input modules and via NF inputs in the system digital call stations.

Connection to a fire alarm system

15.5 System Features

15.5.1 Audio monitoring

All audio information can be selected locally on the VA/PA system using the monitor button and can be monitored via the integrated loudspeaker.

The monitor function can be deactivated automatically by pressing a button or via a user-defined timeout.

15.5.2 Alarm mode

The system switches to an alarm mode for alarm announcements.

Announcements with low priority, such as background music, are stopped.

Standard-compliant alarm signalling.

15.5.3 Digital signal processing (DSP)

Per DAL bus audio stream

Adjustable volume

Configurable limiter for the digital call station microphone (DCS, DCSF)

Per Amplifier channel

Adjustable volume

Automatic volume control (AVC)

High-pass filter 2, 4, 6 sequences (cutoff frequency: 20 Hz - 20 kHz)

Low-pass filter 2, 4, 6 sequences (cutoff frequency: 20Hz - 20kHz)

Delay (0-2.000 msec)

Parametric equalizer, 8 bands

Level indicator for audio inputs and outputs.

15.5.4 Audio memory/signals

Audio memory for critical alarms such as evacuation announcements in accordance with IEC EN 60849 on non-volatile flash memory. 16 memory places for 260 sec in total are available. E.g. for prerecorded audio signals (gongs, signals, texts, etc.) for example in accordance with DIN 33404 and KTA 3901, in each digital audio distribution and connection system (maximum 24 Loudspeaker lines each)

System wide audio memory for critical alarms such as evacuation announcements in accordance with IEC EN 60849 on non-volatile flash memory. The memory capacity is approximately 120 minutes.

Audio memory for non-security relevant announcements such as advertising texts or music on a hard drive. The memory capacity is approximately 1000 hours.

15.5.5 Connection of a source to a target taking the following into account

Connection time limit

Activation type – press/toggle

Individual volume

With/without automatic volume control

Multisource; an audio source can be used by several connections simultaneously.

Priority (1-250)

Recording the activation or deactivation of the connection.

Saving the announcement

Partial connection

Timeout

Warning signal, e.g. an attention signal such a gong

Reconnection

Repetition

15.5.6 Error display

The error message can be displayed based on the location.

Error display either by LED or control contact and by means of an entry in the message list.

Error messages are always reported as “OK” after the underlying cause has been rectified.

Error messages can also be automatically reset – if necessary.

Error messages can also be manually acknowledged by means of key(s) or contact(s).

Potential error-specific signalling to LEDs and control outputs.

Monitoring can be completely switched on or off at the device level for each DOM.

15.5.7 Remote control, remote maintenance

The system can be remotely maintained via an open data protocol.

Building management systems, path control machines, or airline passenger information systems, for example, can set any individual announcements and obtain status information from the system.

The system can be maintained remotely via ISDN, for example.

Configuration changes and read outs of all events can be performed over long distances.

15.5.8 Graphical user interface

A user interface customized to specific customer requirements can be implemented easily and flexibly.

15.5.9 Backup amplifier

In the event of failure of an amplifier channel, the system automatically switches to a backup amplifier.

The system switches to the backup amplifier dynamically. In the case of two faulty amplifiers within a group of amp’s which are connected to one backup amp, the priority of the announcement decides which amplifier is switched to the backup.

This is must be dynamically. That means no fixed backup / amp combination. If another time the priority of another not available amp is higher, this will be replaced.

The volume from the faulty amplifier channel is transferred over.

The ratio and the number of main to backup amplifiers can be defined by the user between 4 and 12 amplifier channels to one backup amp

15.5.10 Intercom call stations

Digital call station to digital call station.

Digital call station to digital call station and other loudspeaker circuits.

Digital call station to several digital call stations.

Digital call station to several digital call stations and other loudspeaker circuits.

15.5.11 Configuration

Configuration via graphical user interface.

Parameters can be read and modified in real time.

Certain user privileges can be allocated via user management.

15.5.12 Volume control

Automatic volume control

Each amplifier channel is regulated dynamically depending on the ambient noise and taking into account predefined parameters and back ground music.

Announcements (mostly alarms/evacuations) with a certain priority can be played out on a fixed configured volume, without automatic volume control.

The ratio of ambient noise to changes in volume can be set individually.

The automatic volume control inputs for the sensor microphones can also be used as audio signal inputs, if necessary.

Background music must not have an influence on the automatic volume control

Manual volume control for all audio inputs/outputs via buttons and contacts.

Alarms/evacuations can be output with maximum volume per configuration

(Manual volume control is ignored).

Time-based volume control for all audio inputs/outputs, e.g. reduced volume at tram stops at night time.

15.5.13 Message list

All system-related events are recorded in the message list.

Download of error message with a PC/Notebook.

“External systems”, e.g. emergency power supplies can create entries in the message list.

15.5.14 Power management

Primary power supply: 230 V AC

Secondary power supply (emergency power): 24 V DC

Less important announcements (e.g. background music) can be switched off when there is an outage in the primary power supply (230V AC).

15.5.15 Control inputs & control outputs

Keys with associated LEDs or contacts

Any allocation of control inputs and control outputs for functions, e.g. for triggering priority relays for 100V volume controllers.

15.5.16 Monitoring

Monitoring of connection from digital call station to VA/PA system.

Acoustic monitoring of digital call station microphone or hand microphone (fire control PA panel).

Acoustic monitoring of amplifier channel.

Monitoring of loudspeaker line for short circuits, interruptions and impedance changes via impedance measurement – independent of connections.

The thresholds for short circuits, open lines, and ground faults can be customized.

Monitoring of loudspeaker line for short circuits or interruptions by means of EOL (end of line module) – independent of connections.

Monitoring of loudspeaker line for ground faults.

Independent of circuit-entering loudspeaker lines:

Monitoring of the communication of several VA/PA systems on the network.

Lamp tests/contact tests via button or contact.

Error in data interface to fire panels .

Failure in primary and secondary power supply (emergency power)

15.5.17 Wiring

Each required system can be wired quickly and clearly using only a few system cables.

15.5.18 Networking

Up to 250 digital audio distribution and connection systems on a network.

Networking via 10, 100 Mbit(recommended) or Gbit Ethernet.

Transmission of various audio data is only restricted by the transmission bandwidth.

Up to 120 audio data channels on a 100 Mbit network.

Up to 16 different audio channels items per digital audio distribution and connection systems can be processed simultaneously over the network.

SNMP (Simple Network Management Protocol) to monitor network elements from a central station.

Specified delay of local destination for a connection to offset the latency period of the network destinations.

VLAN ID can be adjusted for integration in existing network structures,

e.g. taking into account other network systems such as CCTV, etc.

15.5.19 Timer programs

Time-controlled connection for bell systems, e.g. in schools.

Ime-based volume control for all audio inputs/outputs, e.g. reduced volume at tram stops at night-time.

Time-controlled activation/deactivation of monitoring of loudspeaker lines.

Time-controlled actuation/deactivation of amplifier channels monitoring.

15.5.20 Time synchronization

The individual devices are synchronized. Master/Slave configuration possible.

External time synchronization via NTP (Network Time Protocol) possible.

External time synchronization via GPS possible.

Automatic adjustment for daylight saving changes.

15.5.21 Destination – Group formation

Any circuits (destinations) can be grouped together in pre-selection points.

Circuits can be grouped in any nested format.

15.5.22 Temporary storage of an announcement (automatic)

Announcements can automatically save and played back within a user-defined timeout period when the required points are released.

Status display and control options via buttons and control contacts.

15.5.23 Temporary storage of an announcement (manual)

Record, listen and playback possible.

15.5.24 Audio matrix

Any input can be route to any output without any restrictions

Input can be a call station, analogue audio input, and audio memory

Out put can be a loudspeaker line, call station and analogue audio output

15.6 Interfaces

15.6.1 Connection to fire alarm system

This system also allows for alarm management with prepared texts in the case of an emergency by means of an interface to the fire detection system. For this, the system must be connected to the emergency power supply, and the loudspeakers should be installed in such a way that they are fire resistant in the event of a fire escaping beyond the fire compartment

The interface is monitored continuously; in the event of a failure/interruption, an error message occurs on the VA/PA system and the fire alarm control panel. The triggering of the alarm can be defined via control zones. Any other errors that may arise, such as the failure of a power amplifier, digital call station or routing to the loudspeakers, will be forwarded to the fire alarm control panel as a trouble alarm. Trouble alarms can be reset via the fire alarm control panel. A date/time synchronization can be configured between the VA/PA system and the firm alarm control panel.

15.6.2 Connection to a building management system (or safety management system)

A building management system (or safety management system) and the VA/PA system must be linked by means of the relevant interfaces; mere contact connections/controls are eliminated. The system is connected to the fire detection system via the fire control settings.

With regard to the VA/PA system that is to be linked to the safety management system, the following functions at the very least must be in operation or available:

Circuit selection (must also be possible for each available call circuit to be selected from the master computer)

Group call (groups can be defined freely in terms of software)

Collective call from digital voice memory

Alarm sounds

System synchronization (messages, time)

Message fault VA/PA System on building management system (or safety management system)master computer

Message fault amplifier on building management system (or safety management system)master computer

Message fault digital call station on building management system (or safety management system)master computer

Message fault loudspeaker on building management system (or safety management system)master computer

Message fault call circuit (by monitoring circuits) on building management system (or safety management system)master computer

It must be possible to configure and program the VA/PA system via a PC. The software enables the loudspeaker matrix and digital call stations to be monitored and controlled remotely. A color graphic depicting all of the components to help users identify errors more effectively. The PC and the system are at least connected via a serial interface.

15.6.3 System components

15.6.3.1Digital audio distribution and connection system for up to 8 loudspeaker zones

Module with audio signal processing for connecting and controlling power amplifiers and for connecting loudspeaker circuits.

Four independent audio outputs for connecting power amplifiers (up to 500 Watt per channel) and for simultaneous processing of up to four different audio information items per module.

Connection of an audio signal to one or two user-defined loudspeaker zones. In total up to eight loudspeaker circuits per module. Either up to 8 loudspeaker circuits can be operated as transmission line technology or as up to 4 loops, where required, the two technologies can be used in combined mode via the configuration as two loops and 4transmission lines.

Upgrade to a complex alarm/public address system through integrated LAN interfaces.

Continuous monitoring of power amplifiers by means of a test tone. In the event of a failure of a power amplifier, a backup amplifier will automatically and dynamically replace the faulty power amplifier. The defined loudness level is also taken into account for the backup amplifier.

Continuous inaudible monitoring of loudspeaker lines (ground faults, short circuits, interruptions, and impedance deviations with specified tolerances for each loudspeaker circuit), even in power-saving mode, independent of activated announcements. An end of line module can also optionally be used as a line termination and the line to the EOL can be monitored.

This ensures that short-circuited loudspeaker circuits are disconnected without affecting the rest of the system.

Continuous monitoring of line and microphone of up to four connectable digital call stations or universal input modules.

All errors are detected, displayed and recorded (message list) within seconds.

Audio filters such as parametric equalizers, high and low-pass filters and delays per audio channel can be set.

For each of the four amplifier channels, there are four sensor inputs for optional, continuous and automatic volume control in real time, independent of the ambient noise level.

It is possible to monitor locally all of the input and output channels via the integrated loudspeaker and monitor button.

Eight programmable, potential-free contact outputs for controlling external components (e.g. priority relays) or for signalling various indicator states (collective fault messages).

Four Ethernet 100 Mbit/s interface connections with switch function.

Integrated bus for optional connection of an additional module (e.g. time synchronization Module). Display for indicating operation status, errors, circuit connection, and active power-saving mode via multi-colored LEDs.

Emergency control operation during a power failure to preserve battery capacity – this means not activating background music or low-priority announcements when there is a failure in the primary power supply. The connected amplifiers are switched to stand-by mode.

Non-volatile audio memory for up to 260 seconds, freely scalable, for user-specific canned audio. Various gong and alarm signals in accordance with DIN VDE 33404, ZBV.

Emergency 24 V power supply as secondary power supply.

15.6.3.2 System communication unit

The system communication unit acts as a digital audio memory for the VA/PA system.

This allows more than 50 channels of audio data to be recorded and played back at the same time – regardless of the available bandwidth from the network.

The connection to a VA/PA system network is established via Ethernet and is monitored continuously.

As per IEC EN 60849, the audio data for critical alarms and evacuation messages is stored on non-volatile flash memory. The memory capacity is approximately 2 hours.

Additional messages, such as announcements, signals or advertising texts, are stored on a hard drive. The memory capacity is approximately 1,000 hours.

The component can also be used for logging and recording announcements. These are stored on the hard disk and saved with the date, time and trigger information.

Including a call stacker function which allows to stored announcements temporarily and played them back simultaneously and automatically within a particular time limit when the desired point is released.

DC emergency power supply as secondary power supply.

15.7 Digital call stations

15.7.1 Digital call station with 12 keys

Fully digital call station with electret microphone (cardioid characteristic) on a flexible 300 mm long gooseneck.

Integrated broadband loudspeaker for monitoring and previewing purposes as well as intercom functions.

Continuous acoustic monitoring of microphone capsule. Acoustic monitoring is not only used to check the functioning of the voice coil but also of the capsule.

12 freely programmable buttons, which can be labeled.

13 integrated and 12 freely programmable LED display elements including a combined operation and error display.

Digital transmission of control signals and all four audio signals to and from the digital call station and the supply voltage via DAL link.

The digital call station is connected to the VA/PA system in star-shaped topology via CAT 5E cable (shielded) and RJ45 socket (up to 300 meters distance).

Optional fiber optic connection for distances up to 2,000 meters.

RJ12 socket for connection with up to 6 expansion modules via daisy chain.

An audio input with 2 cinch sockets at the back of the digital call station for connecting an auxiliary device allows audio playback outside of the central control unit.

An audio output can be used for monitoring purposes or for audio distribution or recording.

In- and output are independent from the microphone and can be used simultaneously

15.7.2 Digital Keyboard Module

Digital keyboard module for digital call stations

Allows an extension of 18 extra freely programmable keys that can be labeled as well as 18 LED display elements.

Digital transmission of control signals to the digital call station.

The keyboard module is supplied with 24 V DC by the digital call station.

15.8 Interfaces

15.8.1 Universal Interface Module

Interface module for connecting two analogue audio inputs, two analogue audio outputs, and 48 control contacts.

The two audio inputs are both asymmetrical (RCA) and symmetrical (XLR-f).

The two audio outputs are both asymmetrical (RCA) and symmetrical (XLR-m).

The 48 control contacts can be set via software configurations in any combination as potential input contacts and/or output contacts; eight can be monitored.

Digital transmission of control signals and all audio signals to and from the VA/PA system and the supply voltage via DAL link.

15.8.2 Volume controller 30 W

10-level volume controller with 24 VDC priority relay suitable for 4-wire installation.

The volume of announcements or background music can be controlled specifically or switched off in certain rooms. The integrated priority relay ensures that the loudness level of alarm or evacuation announcements is in accordance with regulations by overriding the volume controller when the volume is set to a low level or is switched off.

Input	100 V/30 W
Levels	10 + off
Dimensions	86 x 86 mm
Material Plastic	
Switch design	DC 24 V/6-core
Design	Transformer
Weight	0.16 kg
Priority relay	24 V DC

15.8.3 Loop – Isolator – Module (LIM)

Loop isolator module for setting up a short circuit and wire-break tolerant 100 V loudspeaker – loop wiring system with speaker loop technology. The modules monitor current in the loudspeaker loop. In the case of an overcurrent, they switch off the faulty section of the loudspeaker loop, for example in the event of a short circuit. The faults in the line are displayed at the DOM and VCM. Each module has three two-pin terminals for connecting the loop and the loudspeaker. Wires with a cross section of up to 2.5 mm2 can be connected to the terminals. Additionally, a visual indicator of the operating status is displayed on the module. The loop isolator module is fitted with a stable, compact IP66 housing with sufficient room for wiring, and thus can be used in projects with difficult surroundings, e.g. for industry.

15.8.4 GPS time synchronization module

The module is connected to the VA/PA system directly and ensures time synchronization by means of GPS signals. This allows accurately timed, automated announcements (e.g. bell systems in schools), time-controlled volume adjustments (e.g. reduced volume at train stations at night-time), or simply precise time-logging of announcements or trouble alarms.

The module is connected to the VA/PA system directly using a standard CAT5 cable (max. 10m).

A fault in the module or satellite reception is entered in the message list.

The GPS signal is transmitted to the receiver via the antenna and coaxial cable.

15.9 AMPLIFIERS

15.9.1 Power amplifier 4 x 500 W/100 V; class D, 24 V DC

Highly efficient class D power amplifier.

The power amplifier includes the following characteristics:

Complies with IEC BS EN 60268-3, 55013, and 55020 standards

Self-monitoring and self-testing via microcontrollers

Protected against overload, short circuits and over-heating

Built-in fan with temperature-controlled rotation speed control, with airflow from front to back of device

Monitoring of the fan's t self, if one is failed – the left fan must set on 100% speed automatically.

LED status display per channel for POWER, SIGNAL, CLIP, and ERROR

LED status display for MAINS POWER; BATT POWER, CPU STATUS, SYS FAULT

Emergency power supply via 24 V DC

Symmetrical audio inputs and control via CAT 5 cable with RJ45 connector

100 V outputs via pre-assembled system cable, lockable Technology Class D, 100 V outputs with transformers

Output power (at 230 V mains supply) 500 W with 25 Ω load

Output power (at 24 V DC emergency power supply) 500 W with 25 Ω load

Mains supply 230 V AC 50/60Hz +10% to -15%

Emergency power supply 21.5 V DC to 28.5 V DC

Frequency response 50 Hz to 22 kHz ± 3dB

Distortion factor < 0.3% at 1 kHz sine

Signal-to-noise ratio 90 dB (A-weighted)

Channel separation > 75 dB

Efficiency at maximum power > 80%

Color RAL 7016

Ambient temperature range -5 °C to +55 °C

Relative humidity up to 90 % (non-condensing)

15.9.2 Power amplifier 2 x 250 W/100 V; class D, 24 V DC

Highly efficient class D power amplifier.

The power amplifier includes the following characteristics:

Complies with IEC BS EN 60268-3, 55013, and 55020 standards

Self-monitoring and self-testing via micro controllers

Protected against overload, short circuits and over-heating

Built-in fan with temperature-controlled rotation speed control, with airflow from front to back of device

Monitoring of the fan's t self, if one is failed – the left fan must set on 100% speed automatically.

LED status display per channel for POWER, SIGNAL, CLIP, and ERROR

LED status display for MAINS POWER; BATT POWER, CPU STATUS, SYS FAULT

Emergency power supply via 24 V DC

Symmetrical audio inputs and control via CAT 5 cable with RJ45 connector

100 V outputs via pre-assembled system cable, lockable

Technology	Class D, 100 V outputs with transformers
Output power (at 230 V mains supply)	250 W with 40 Ω load
Output power (at 24 VDC emergency power supply)	250 W with 40 Ω load
Mains supply	230 V AC 50/60Hz +10% to -15%
Emergency power supply	21.5 V DC to 28.5 V DC
Frequency response	50 Hz to 22 kHz ± 3dB
Distortion factor	< 0.3% at 1 kHz sine
Signal-to-noise ratio	90 dB (A-weighted)
Channel separation	> 75 dB
Efficiency at maximum power	> 80%
Color	RAL 7016
Ambient temperature range	-5 °C to +55 °C
Relative humidity	up to 90 % (non-condensing)

15.9.3 Power amplifier 2 x 400 W/100 V; class D, 24 V DC

Highly efficient class D power amplifier.

The power amplifier includes the following characteristics:

Complies with IEC BS EN 60268-3, 55013, and 55020 standards

Self-monitoring and self-testing via micro controllers

Protected against overload, short circuits and over-heating

Built-in fan with temperature-controlled rotation speed control, with airflow from front to back of device

Monitoring of the fan's t self, if one is failed – the left fan must set on 100% speed automatically.

LED status display per channel for POWER, SIGNAL, CLIP, and ERROR

LED status display for MAINS POWER; BATT POWER, CPU STATUS, SYS FAULT

Emergency power supply via 24 V DC

Symmetrical audio inputs and control via CAT 5 cable with RJ45 connector

100 V outputs via pre-assembled system cable, lockable Technology Class D, 100 V outputs with transformers

Output power (at 230 V mains supply) 400 W with 25 Ω load

Output power (at 24 VDC emergency power supply) 400 W with 25 Ω load

Mains supply 230 V AC 50/60Hz +10% to -15%

Emergency power supply 21.5 V DC to 28.5 V DC

Frequency response 50 Hz to 22 kHz ± 3dB

Distortion factor < 0.3% at 1 kHz sine

Signal-to-noise ratio 90 dB (A-weighted)

Channel separation > 75 dB

Efficiency at maximum power > 80%

Color RAL 7016

Ambient temperature range -5 °C to +55 °C

Relative humidity up to 90 % (non-condensing)

15.10 SPEAKERS

Speakers shall be especially designed for broadcasting high quality, integrated emergency fire alarm signals and voice communications and approved by an appropriate authority for use in such situations.

Speakers shall be ceiling, wall mounted or Horn Speaker as shown in the schedule of work and shall be completed with mounting brackets accessories etc. Speakers shall be in metal enclosures only.

Speaker external appearance shall be approved by the Engineer-in-Charges.

Speakers shall be interconnected in the zone configuration.

15.10.1 Loudspeakers

15.10.1.1 CeilingLoudspeaker

6W Ceiling speaker with metal grille and 6/3W taps

Parameters	Values
Max power	9W
Rated power	6W
Power taps @ 100V	6W / 3W

Parameters	Values
Sound pressure level at 6W/1W (4kHz,1m)	98 dB / 90 dB
Frequency range (-10dB)	80 Hz -20 kHz
Dispersion angle(1kHz/-6dB)	160°
Rated input voltage	100 V / 70 V
Rated impedance	1.7 kΩ / 3.3 kΩ
Connection	Push terminal
Dimensions(Φ x H)	Φ180mm x 55 mm
Hole cut-out size	150 mm
Size of speaker	5”
Weight	0.6 kg
Color	White (RAL 9010)
Weight of Magnet	

15.10.1.2 Wall mount Loudspeaker

6W wall mount Loudspeaker

Parameters	Values
Max power	9 W
Rated power	6 W
Power taps @ 100V	6 W / 3 W
Sound pressure level at 6W/1W (1kHz,1m)	96 dB / 88 dB
Frequency range (-10dB)	110 Hz - 13 kHz
Dispersion angle(1kHz/-6dB)	140°

Parameters	Values
Rated input voltage	100 V / 70 V
Connection	Cable
Dimensions (diameter x height)	260 x 180 x 120 mm
Weight	1.08 Kg
Case material	ABS

15.10.1.3 Column Loudspeaker

20 Watt column speaker with high resistance against harsh environmental influences, large frequency range and high sound pressure level for announcements and/or background music in large areas.

Max power	30 W
Rated power	20 W(10W × 2)
Power taps @ 100V	20 W / 10 W / 5 W / 2.5 W
SPL at 20 W / 1W(350Hz-15kHz,1m)	105 dB / 92 dB
Frequency response (- 10 dB)	250 Hz - 20 KHz
Dispersion angle (1KHz / -6 dB)	160°
Rated input voltage	100 V / 70 V
Rated impedance	500 Ω / 1 KΩ / 2 KΩ / 4 KΩ
Connector	Fire-resistant cable
Dimensions (W × H × D)	165 × 150 × 344 mm
Weight	3.75 Kg
Color	White(RAL9003)
Speaker size	4" × 2
Operating temperature	−25 ℃ to + 55 ℃
Storage temperature	−40 ℃ to + 70 ℃
Relative humidity	< 95 %

15.10.1.4 High fidelity Wall mount Loudspeaker

40W High fidelity wall mount Loudspeaker

Parameters	Values
Max power	60 W

Parameters	Values
Rated power	40 W
Power taps @ 100V	40 W / 20 W/10 W
Sound pressure level at 6W/1W (1kHz,1m)	101 dB / 86 dB
Frequency range (-10dB)	100 Hz - 20 kHz
Dispersion angle(1kHz/-6dB)	160°
Rated input voltage	100 V / 70 V
Connection	Cable
Dimensions (diameter x height)	172 × 302 × 165 mm
Weight	3.2 kg
Color	White (RAL9003)
Case material	ABS

15.10.1.5 Cabinet Speaker

60 W Cabinet Speaker

Parameters	Values
Max power	60 W
Rated power	80 W
Power taps @ 100V	60 W / 30 W / 15 W
SPL at 60W / 1W (1k Hz, 1m)	110 dB / 92 dB
Frequency response (- 10 dB)	80 Hz - 20k Hz
Dispersion angle(1kHz/-6dB)	135 °
Rated input voltage	100 V / 70 V / 8Ω

Parameters	Values
Connector	Binding post terminals
Dimensions (W × H × D)	193 × 344 × 202 mm
Diameter of speaker	6.5" woofer, 1" tweeter
Weight	3.8 kg
Color	White (RAL9003)

15.11 PC call station

The PC call station is used to easily address zones, transmit and preview and voice announcements, and input and display text messages. It is operated by means of a graphical user interface which displays the individual object with the loudspeaker or display zones. The application can also be used by means of a touch screen, so it has a simple and clear design and saves on space.

The graphics are created simply and conveniently using a bitmap of the building.

A call station is required for voice announcements.

Functions

Full-screen application, suitable for use via touch screen

Graphical view (e.g. building layout) for zone selection and status display

Zone display in table form with selection and status display

LIVE announcements via PTT (press to talk) button on screen or call station

Record, preview and transmit announcements.

Input text messages for display view

Text display in conjunction with voice announcements

Time-controlled text display, in intervals or loops

Status display for each zone – assigned or error

Several PC call stations on one TCP/IP LAN

Project-specific Help function

15.12 PC call station server

Software license with dongle for use with a PC call station and PC call station server on a hardware basis. Enables an interface to be adapted to an external discipline.

15.13 Remote Paging Microphone

Digital voice evacuation system remote paging microphone.

Each microphone of 8 zone capacity.

Zone expansion by connection with expansion unit. iv. System indicators of AC, DC, fault, Mic status and test.

6 inputs & mic/line selection buttons.

8 zone selection buttons with three-coloured indicators

Reset/Cancel, All Call & Call buttons.

Two RJ45 ports for input and link output. ix. CAT5 or CAT6 cable communication up to 600 meters.

AC 230V and DC24V battery inputs.

Built-in monitor speaker.

Voice Alarm Controller (VCA)

Digital voice evacuation system all in one amplifier.

Specifications meet the standards of BS EN54-32 & EN608409.

EN54-16 standards certificate is under taken.

Built-in 240W & 500 8 zone class-D amplifier.

Integration of EVAC system, paging system, PA system & BGM system together.

Built-in two separate players for EVAC and alert voice message by SD card.

Built-in 8 zone AB speaker line low impedance supervision.

Built-in amplifier auto changeover into standby when fault.

With external amplifier input to expansion the power.

Capacity of connection 8 unit's remote microphone.

Red button EVAC message push to activate with priority except fireman mic.

8 zone speaker outputs with separate zone volume control.

8 zone separate indicator for EVAC, fault, music/paging & select.

System indicators of AC, DC, fault and indicators for EVAC, alert & fireman mic.

Zone capacity of 96 zones by cascaded 11 unit's router.

With 8 programmable control inputs and 8 programmable control outputs for voice evacuation system.

With Fault, EVAC outputs and Reset input for third party system integration.

With fireman microphone of highest priority.

Priority level: fireman mic, EVAC, input 1, remote microphone, timer & BGM.

Two combo inputs for mic/line, 4 line inputs and one REC output.

Two RJ45 for cascade router, two RJ45 for remote microphone input and two RJ45 for LAN/WAN/Internet network.

IP network module for optional to buy. The IP network

AC 230V and DC24V battery input. Auto switch into the battery backup when AC fails.

Description	8 Zone Voice Evacuation Amplifier
Rated Power Output	240W
Fireman Microphone	5Mv, 600Ω
Line 1-2 Inputs	385mV, 10kΩbalanced Combo
Line 3-6 Inputs	350mV, 10kΩ, RCA
Frequency Response	80Hz~20kHz
THD	＜1% at RMS,1KHz
S/N Ratio	>70dB

Technical Specification:

Speaker Output	100V AB 8 zone speaker outputs
REC Output	200mV
Control Input & Output	8 programmable control inputs: Max 3.3V (voltage mode) or 0V closed contact 8 programmable control outputs: 0V closed contact Control output for fault & EVAC: 0V closed contact Reset control input: 0V closed contact
Voice Message	MP3 or WMA format, two separate players of SD card with protection cover, programmable voice message up to 255, 10 years valid
Event Record	HEX format, Hard Flash memory, events up to 1000 records, 10 years valid

Operation Environment	Operation Temp: +5℃ ~ +40℃ Store Temp: -20℃ ~ +70℃ Operation Humidity: <95%
Power Consumption	600W
Power Supply	AC230V or 115V & DC24V battery inputs, 50-60HZ

16.0 RACEWAY

All raceway shall be of 1.6mm/2.0mm thick G.I. The raceway shall have Z- section, hole with thread for cover screw, coupler plate, cover, junction box, fly cover etc. as required. The screw for cover fixing shall be counter sunk type. The size of raceway shall be as follow.

WIDTH WIDTH (mm)	HEIGHT (mm)	THICKNESS (mm)	COVER THICKNESS (mm)
50	40	1.6	1.6
75	40	1.6	1.6
100	40	1.6	2.0
150	40	2.0	2.0
200	40	2.0	2.0
300	40	2.0	2.0

17.0 SAFETY MATERIALS

17.2 APPLICABLE CODES & STANDARDS

A. IS : 15652 Insulation mats

B. IS : 2878 Portable C02 Fire Extinguisher

C. IS : 2546 : Fire Buckets

D. ANSI/NFPA 70 - National Electrical Code.

17.3 SUBMITTALS : Product Catalogues.

17.4 SPECIFICATION

17.4.1 INSULATION MATS

Insulation mats conforming to IS: 15652 shall be provided in front of main switch boards and other control equipment as specified.

17.4.2 FIRST AID CHART AND FIRST AID BOX

Charts (one in English, one in Hindi, one in Regional Language), displaying methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate places. Standard First Aid Boxes containing materials as prescribed by St. John Ambulance brigade or Indian Red Cross should be provided in sub-station.

17.4.3 DANGER PLATE

Danger plates shall be provided on HV and LV equipments. LV danger notice plate shall be 200 mm x 200 mm made of mild steel atleast 2 mm thick vitreous enamelled white on both sides and with inscriptions in signal red colour on front side as required.

Size of the HV Danger Notice plate shall be 250 mm x 200 mm and 2 mm thick.

17.4.4 FIRE EXTINGUISHERS

Portable CO2 conforming to IS: 2878-1976 dry chemical (conforming to IS 2171-1976) extinguishers shall be installed in the sub-station at suitable places (like HT/LT panel rooms) as specified. Foam type fire extinguisher shall be installed in Transformer Room.

17.4.5 FIRE BUCKETS

Fire buckets conforming to IS: 2546-1974 shall be installed with the suitable stand for storage of water and sand.

17.4.6 TOOL BOX

A standard tool box containing necessary tools required for operation and maintenance shall be provided in sub-station.

17.4.7 CAUTION BOARD

Necessary number of caution boards such as "Man on Line" "Don't switch on" etc. shall be available in the sub-station.

The Caution Board shall be of size 300 mm x 200mm made of mild steel, 2mm thick, vitreous enamelled white on both sides and with inscriptions in original red colour on front side as required.

17.4.8 KEY BOARD

A key board of required size shall be provided at a proper place containing keys, and all other keys of sub-station and allied areas.

The Key board shall be made of 12mm thick first class teak wood shall be of size 400 mm x 300m and with adequate depth to hold the keys. It shall be provided with a lockable type hinged glass door made of 12 mm. thick first class teakwood frame with 3 mm thick sheet glass fixed with piano hinges. The key board shall enough number of hooks for hanging the castle keys and all other keys of the sub-station and allied areas. It shall be painted with one coat of wood primer and two coats of white enamel paint.

18.0 Close Circuit TV (CCTV) AND ACCESS CONTROL

Scope of work involves supply and installing suitable nos of Day / Night cameras including its support in and around the complete IIFT campus as per approved drawings, basements, boundary wall at suitable intervals and all the main gates with suitable mounting arrangement in a Vandal Proof Housing. Laying, terminating & connecting copper cables with redundancy between cameras & control room. Complete system is to be designed as per above requirements and a scheme along with layout and inventory is to be submitted to the Engineer-in-Charge for approval, before taking up the installation work.

18.1 IP Verifocal Dome Camera

Camera shall be IP based network color camera suitable for indoor Application with following minimum features:

H.265, JPEG based hardware compression with built-in web server

Direct IP based (without external converters, cards, etc)

Auto focus

Power over Ethernet/ 12 VDC (contractor shall provide power convertor required, if any)

Minimum Resolution : 2944 x 1656 (5MP)

Intelligent video capabilities, Face detection, Video Motion Detection, Camera tamper like defocus, Scene change

Multiple Streaming: min. triple

ONVIF profile S, G features

IK10 & IP67, WDR/DWDR: 80 db

Alarm and audio interface 1/1

Connections : Network: IEEE802.3, 10BaseT/100BaseTX Ethernet networks (RJ-45) for LAN/WAN TCP, UDP, IGMP, SNMP, HTTP, IPv4/ v6, DHCP, FTP, DNS, SMTP, Security - 802.1x, AES 256, PCI-DSS Compliant

Video

Lens : Varifocal (2.8- 4.5 to 12.0 – 16.5 mm) DC-iris

Progressive Scan : 1/2.9” CMOS or Better

Light sensitivity: Color: 0.014 Lux @ (F1.4, AGC ON), 0 Lux with IR

IR sensitive black/white video at night

Frame: 2MP @ 25 fps or better @ max. resolution

Functions

Built-in video motion detection

Scheduled and triggered event functionality with alarm notification Pre and post alarm buffer

Digital time, date code embedded

Password protection for restricted camera access

Certification: IS / UL, FCC or CE for Fixed cameras shall be provided.

Local Storage (support for SD card of minimum 128 GB)

IR illuminators: IR illuminators LED based for minimum 30 meters at 0 lux shall be inbuilt in each camera

18.2 IP Verifocal Bullet Camera

Camera shall be IP based network color camera suitable for indoor Application with following minimum features:

H.265, JPEG based hardware compression with built-in web server

Direct IP based (without external converters, cards, etc)

Auto focus

Power over Ethernet/ 12 VDC (Bidder shall provide power convertor required, if any)

Minimum Resolution: 2944 x 1656 (5MP)

Intelligent video capabilities: Face detection , Face detection, Video Motion Detection, Camera tamper like defocus, Scene change

Multiple Streaming : min. triple

ONVIF profile S, G features,

IK10 & IP67, WDR/DWDR:80 db

Alarm and audio interface 1/1

Connections : Network: IEEE802.3, 10BaseT/100BaseTX Ethernet networks (RJ-45) for LAN/WAN TCP, UDP, IGMP, SNMP, HTTP, IPv4/ v6, DHCP, FTP, DNS, SMTP , Security - 802.1x, AES 256, PCI-DSS Compliant

Video

Lens : Varifocal (2.8 - 5.1 to 12.0 – 16.5 mm) DC-iris

Progressive Scan : 1/2.9” CMOS or Better

Light sensitivity: Color: 0.014 Lux @ (F1.4, AGC ON), 0 Lux with IR

IR sensitive black/white video at night

Frame: 2MP @ 25 fps or better @ max. resolution

Functions

Built-in video motion detection

Scheduled and triggered event functionality with alarm notification Pre and post alarm buffer

Digital time, date code embedded

Password protection for restricted camera access

Local Storage (support for SD card of minimum 128 GB)

IR illuminators : IR illuminators LED based for minimum 50 meters at 0 lux shall be inbuilt in each camera

18.3 IP PTZ Camera

Camera shall be IP based network color camera suitable for indoor Application with following minimum features:

H.265/H.264, JPEG based hardware compression with built-in web server

Direct IP based (without external converters, cards, etc.)

Auto focus and Electronic Image stabilization (EIS)

Support object tracking and rapid focus on object in live view

Optical defog to ensure clear image in foggy condition

Hi-Power over Ethernet / 24 VAC (Bidder shall provide power convertor required, if any)

Minimum Resolution : 1920 x 1080 @ 25/30Fps

Intelligent video capabilities: ,Video Motion Detection, Camera tamper like defocus, Scene change

Movement : configurable, 360° endless, PAN Speed : 0.1°/s to 200°/s preset speed 200°/s and Movement range : -10 to 90°

Tilt speed :configurable ,from 0.1°/s to 120°/s, preset : 200°/s

Presets 250, patrol 4 pattern scan record

Feature: patrol, power off, Park action preset freezing etc.

Camera support network failure recording on board in card, when network reconnect recording push to recorder.

Simultaneously 20 live view streams

Multiple Streaming : min. triple

ONVIF , CGI , API and 3rd party integration

IK10 & IP67, surge protection

Alarm and audio interface 5 in / 2 out

Connections

Network: IEEE802.3, 10BaseT/100BaseTX Ethernet networks (RJ-45) for LAN/WAN TCP, UDP,

IGMP, SNMP, HTTP, IPv4/ v6, DHCP, FTP, DNS, SMTP

CVbs output , rs485 : pelco-P & D and OEM make

Video

Lens : Varifocal 4.5 -6 to 135 - 180,30x optical zoom) Auto Iris

Progressive Scan : 1/2.9" CMOS or Better

Light sensitivity: Color: 0.01 Lux @ (F1.5, AGC ON), 0 Lux with IR

IR sensitive black/white video at night

Frame: 25/30 fps @ max. resolution

Functions

Built-in video motion detection

Scheduled and triggered event functionality with alarm notification Pre and post alarm buffer

Digital time, date code embedded

Password protection for restricted camera access

WDR: 120dB, HLC, BLC

Privacy mask : 20 or more programmable

Certification: IS / UL, FCC or CE for Fixed cameras shall be provided.

Local Storage (support for SD card of minimum 256 GB)

IR illuminators : IR illuminators LED based for minimum 200 meters at 0 lux shall be inbuilt in each camera

18.4 IP ANPR Camera

Camera shall be IP based network color camera suitable for indoor Application with following minimum features:

H.265/H.264, JPEG based hardware compression with built-in web server

Direct IP based (without external converters, cards, etc)

Auto focus

Power over Ethernet/ 12 VDC (Bidder shall provide power convertor required, if any)

Minimum Resolution : 1920 x 1080P (2 MP)

OCR inbuilt in camera

Multiple Streaming : min. triple

ONVIF profile S, G features, CGI, ISAPI

IK10 & IP67, WDR:120Db

Connections : Network: IEEE802.3, 10BaseT/100BaseTX Ethernet networks (RJ-45) for LAN/WAN TCP, UDP, IGMP, SNMP, HTTP, IPv4/ v6, DHCP, FTP, DNS, SMTP

Video

Lens : Varifocal (2.8-12.0mm/ 8-32mm) DC-iris

Progressive Scan : ½.8" CMOS Light sensitivity

Light sensitivity: Color: 0.01 lux @(F 1.4, AGC ON), 0 lux with IR

IR sensitive black/white video at night

Frame: 25/30 fps or better @ max. resolution

Functions

Built-in video motion detection, Camera tamper like defocus, Scene change

Scheduled and triggered event functionality with alarm notification Pre and post alarm buffer

Digital time, date code embedded

Password protection for restricted camera access

Certification: IS / UL, FCC or CE for Fixed cameras shall be provided.

Local Storage (support for SD card of minimum 128 GB)

IR illuminators : IR illuminators LED based for minimum 60 meters at 0 lux shall be inbuilt in each camera

18.5 NVR : General

NVR shall be a fully IP based integrated Network Video recorder with Network Video Management Software and IP cameras management suitable for the IP cameras as defined above. The NVR shall be located at Server Room. The NVR shall be able to connect to all network-connected devices. The video recording servers shall have disk space for online video storage and access to high capacity archiving mechanisms for the removal of stored video to off-line media. Video Management Software and Cameras shall be from same OEM.

Automatic IP camera discovery and configuration

RAID, 1,5,6,10 with 24/7 operation

Receive encoded live video from IP cameras, Play back video while still recording from the same camera; Store live video to hard disk, Archive previously stored video to off-line storage media, anywhere, anytime.

Allow alarms/events to initiate recordings

Scheduled recordings up to 12 MP camera , shall support min 64 IP cameras @ 2MP 25fps and expandable to 12cameras per NVR Server.

Initiate recordings based on video motion detection (on a continuous basis & scheduled for particular times, days, months, etc)

Report any IP camera failure or recoding failure to the system

Provide a full log of all system status (camera, server availability, etc)

Search for recordings (by camera & time, by motion detection, by alarms/events)

Network management with Security with passwords for each camera.

Support full frame rate on all inputs from the IP network cameras with ANPR camera

Software shall have a provision for Q-CIF, 2CIF and 4CIF configuration minimum or better

Interfaces with IT industry Standard Hardware

Processor : Intel® Xeon® 4-core (64-bit) E3-1225 V5 CPU @ 3.30GHz or Better

Recording bandwidth 512 Mbps , outgoing bandwidth 512Mbps

Ram: 8GB or Better

IS / UL, CE, FCC

16 sata with 8 TB HD capacity, SAS interface to expand storage should support

4 RJ-45 10/100/1000 Mbps self-adaptive Ethernet interface, support ANR, N+1

Alarm : 16 input/8 output on NVR or through Cameras

RS 232 and RS 485 and 1 eSata interface

Video Management Software features

It should be capable of providing web based access

With OS Linux or window with necessary software license and shall support mentioned analytic along number plate recognition etc.

The NVR may be integrated to separate servers with 42” / other higher size monitor. Monitor should support HDMI, VGA, and Audio In/Out etc.

Administrators shall be able to view camera details, change camera settings and configure video settings.

The NVR should have capability of connecting to all the IP cameras in its region as well as further connectivity with the NVR.

Alarm Monitor : When an alarm occurs in the NVR/Administration server, the live video output of the camera associated with that alarm should be switched directly to the alarm monitor.

View Option

Single camera view

1/8/16/32/48/64 or better

Sequence view

Must be able to view cameras from NVR

18.6 ACCESS CONTROL

Controller Features

Multi -door Access Controller, Accessible Card Reader: Wiegand readers up to 4 door & RS485 readers upto 8 doors and expandable to 16 reader per controller

Input interface: 4 alarm input, Door Magnetic×2, Case Input×4, Tamper-proof×1;

Output interface: Door Switch Relay×2, Alarm Relay×2

Communication: TCP/IP network communication, with self-adaptive network interface. The communication data is encrypted with AES 128/256 Bit to ensure information security

Processor : 32 bit high speed processor

Storage: 100,000 cards information and 50,000 access control events

Functions supported : Supports multi-door interlocking function, anti-pass back function, multi-card function first card function, super card and super password function, Limited number of card swap, Occupancy control Min & Max number of people inside the are, min 08 different card formats up to 128 bit long etc.

Data safety during controller power off.

SupportsRS485 interface and Wiegand interface for accessing card reader.

Supports alarm event upload (including tamper-proof alarm, unsecured door alarm, forced entry alarm, delayed door alarm, duress card and code alarm, blacklist alarm and alarm for invalid card swiping attempts alarm)

Controller should be supplied with required accessories

RS485 and Wiegand Reader : Equipped with the 32-bit high-speed processor

Built in audio beeper

Led Indicator

Should support RS485 and/or Wiegand protocol

Reading Range 50 to 60 mm

Frequency : 13.56MHz

Certificate : FCC, CE & UL

Exit Buttons

Dimension (L×W×H): 86×86×28.9mm(3.39×3.39×1.14") or similar

Material : aluminum alloy panel, metal button

Power : 3A@36VDC Max

Output Contact: NO/NC/COM Contact

Aging Test: already passed 500 thousand times aging test

It should Suitable for Doors: hollow doorframe and embedded-electric box

Working Humidity: 0 to 95% (relative humidity)

Material should aluminum panel with sandblast

18.7 ACCESS CONTROL SOFTWARE

Supply & Installation of enterprise level Web Based Access Control (Web) + Time Attendance(Web) Software,

Database Supported - MS SQL, including Advance Access Mgmt, Shift Mgmt., Leave Mgmt. & ESS (Employee Self Service)

Supporting: Doors: Unlimited (Access Control)/ Devices (Attendance); Employees: Unlimited. Employee Self Service - login module for Employee/HOD/MANAGER where they can view their attendance; they can apply for leave/manual punch/tour entry/outdoor entry though internet with their login ID & password. Same way manager can online approve all application sent by employee. Comprehensive

Email and/or SMS module for Software to send various SMS &/or Email on the base of different events in Access Control & Time Attendance system. It should support Multi company, multi-location, multi department, multi login with different rights, muti hierarchy of employee. Inbuilt module for ERP & Payroll integration. Graphical Dashboard with summary of complete software. Custom Crystal reports, LDAP user login, Maker Checker, Mobile app and web based NBCC user interface

Access Control shall be seamlessly integrated with CCTC & Alarm system so that CCTV camera can be pop up, recorder based on any alarm from any of the system and later recording can be searched wrt to the respective alarms. Access Control Alarm Management console shall be able to control CCTV camera from Alarm monitor itself.

18.8 VMS

Display mode : 1, 4, 9, 16, 25, 36, 49, 64, 128, Browser, Custom

View manager : An interface to define layouts and pre-set cameras in multiple view mode

View Patrol : Able to switch between different view pages and devices

Layout Manager : An interface to modify display layout, position and the size of live view of camera within layout

Digital Zoom : Zoom in/ Zoom out digitally by mouse scroll wheel

Snapshot : Instant snapshot upon mouse click

Event Notification : Alarm, Motion detection, Connection loss/ auto reconnect between VMS and NVR/camera

Bandwidth Management : Live view with stream 1 in full screen mode or stream 2 in multi-view screen mode (Bitrate adjustable)

Camera Management : Camera control, image setup, camera video format, IR/Exposure setup, Camera information

E-Map

Area maps with camera icons, small live view screen; alarm trigger, event trigger

Google map positioning; E-Map image upload; camera positioning; camera vision angle and direction

Pan, tilt, zoom control; focus, exposure adjustment

Set/ Activate Preset points; Set/ Activate tour routes

USB based Joystick support

Device Search : Auto connect/ Auto scan / Manual add NVR or Camera

Device Information : Model name, IP address, MAC address, type, protocol, streaming port, port, video snapshot

Search Filter : IPCAM, NVR, ONVIF

Recording Search : Search video recording by time, event, channel from multiple cameras/ NVRs Instant view, snapshot and export

Playback control : Continuous forward and backward with speed 1/4x, 1/2x, 1x, 2x, 4x; pause

Synchronized Playback : 32 CH(Local)/ 64 CH(Remote)

Snapshot : Instant snapshot upon mouse click

Digital Zoom : Zoom in/ Zoom out digitally by mouse scroll wheel

Video Export : Export Video clips with AVI, RAW, MP4, MKV, MOV; digital signature supported

Event Source : Multiple cameras/ NVRs

Event Trigger : Video motion detection, Alarm, Video loss

Event Response : Instantly Record video, audio notification, full screen pop-out with live video, email notification

Smart Search : Smart search list for recorded videos by video motion detection/ alarm/ video loss

Permission Management : Unlimited number of users, Active Directory, customized permissions for different user including covert cameras/ NVRs, device management, playback & export

Language : Multiple language support

Operation Log Management : Recorded list of user operation, IPCAM event, NVR event

System status : Instant view of CPU usage, RAM, HDD valid space, Network status

Setting Import/ Export : Possibility to import or export setting packs for convenient VMS setting management

PC NBCC Software : VMS NBCC software with Live view, Playback, E-map, setup

PC Web Browser : Microsoft Internet Explorer 11+ with 16CH display layout.

19.0 BOOM BARRIER:

This specification lays down the general, functional and technical specifications of Automatic Boom Barriers.

FUNCTION:

The barriers are used at entrances / exits to control and review traffic in and out of the premises.

The operation of Boom Barriers can also be linked to access control systems with safety systems.

SYSTEM CONFIGURATION:

The system shall consist of a fixed housing and a movable arm. The housing shall contain the motor, spring and control unit.

GENERAL FEATURES:

1) Electromechanical barriers for passages up to 4.2m, 5m & 6.5m intensive use.

2) Housing finish : Powder Coated Orange

3) The Housing base frame is of stainless steel so as to protect the housing from rustingfrom the bottom

4) Boom: Powder Coated White with refractor strips and LED flashing lights on top.

5) Boom Length : 2 m to 4.2 m for normal lane / 5 m and 6.5 m for extra wide lane.

6) Protection: All housing and internal parts have rust & corrosion free metals / alloys ofhigh strength with suitable epoxy coating as applicable.

7) Easy to use external manual unlock device.

8) Amperometric anti-crushing control.

9) Slowing down setup thanks to two adjustable limit switches.

10) Soft start and slowing down functions adjustable in opening and closing.

11) 4.2 m white painted aluminum arm is provided with two red rubber profiles.

12) Flashing lights on the arm ensure barrier visibility especially at night.

13) Auto close with timer (1s to 90s).

14) Single / 2 Channel loop detector with programmable features (accessory).

15) Electronic module which allows the synchronized movement of two Barriers.

16) Painted fixed support for bars.

17) Stainless steel version available.

TECHNICAL DATA BOOM BARRIER UP TO 3.0M-

Power supply	:	230 Vac
Motor supply	:	24 Vdc
Absorbed power	:	200 W
Max. absorbed current	:	8 A
Torque	:	300 Nm
Opening speed	:	8 sec
Operation cycle	:	Intensive sue
Protection level	:	IP 54
Operating temp.	:	- 20 C/+70 C
Lubrication	:	Grease
Weight	:	105 Kgs

TECHNICAL SPECIFICATION

PART-IV (VENTILATION & PRESSURIZATION)

1.0 STANDARD SPECIFICATION OF AIR CIRCULATION SYSTEM:

1.1 SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts, supply, and installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

1.2 MATERIAL FOR DUCTING:

All duct work shall be constructed out of best quality cold annealed, flat galvanized sheet steel (galvanized to specifications of IS: 277 (latest edition). The grade of coat for GS sheet shall be 120 gm / sq m (table 2 of IS 277-1992).

The joints shall be finished straight and neat. The duct work shall be supported / secured from roof slab or any other building member using angles, rods as may be required.

Thickness of sheets shall be as shown in the tables given below:

Maximum size of Rectangular Duct (in mm)	Round Duct dia (mm)	Thickness of GS Sheet in mm
Upto 750	Upto 600	0.63 (24 G)
751 to 1500	601 to 750	0.80 (22 G)
1501 to 2250	750 to 900	1.00 (20G)
2251 & above	901 & above	1.25 (18 G)

The fabrication of duct shall be done as per IS : 655 (latest edition). Transverse joints, connections, bracing, seam etc. shall be as per IS : 655.

All the ducts over 300 mm in either dimension shall be cross broken except those on which rigid board insulation is applied.

Stiffening angles shall be black structural steel and riveted to the duct work. The longitudinal seam on all ducts may be Pittsburgh seam hooked and hammered.

Ducts of size 600 mm and above shall be reinforced between the joints. Where drive-slips are used, angles shall be riveted to the ducts 50mm from slips.

1.2.1 Duct Construction:

The intent of the above specification is to obtain duct pieces that are robust and rigid; enough to preclude flutter & to achieve minimum amount of air leakage. The contractor may fabricate ducts conforming to any other approved standard to achieve the desired result. Factory fabricated ducts also acceptable subject to meeting all other specifications. However, detailed specifications shall be submitted for approval before adopting the same. Suitable vapour seal type gaskets shall be provided between the duct flanges. Ducting shall be supported from independent hangers fixed to the building structure. In any case the duct shall not be supported from false ceiling, ceiling hangers, light fixtures, support for light fixtures or piping work etc. In case the structure is under construction, inserts and anchors required for duct support shall be set in the building structure at the time of pouring concrete. The Contractor shall prepare detailed drawings of hangers and supports and submit for the approval of Engineer-in-charge. Anchoring of rods shall be done by using metallic expansion fasteners in ceiling for concrete roof. Where ducts are required to be lined or insulated on inner surface, their dimensions have to be enlarged so that cross-section area is not reduced as compared to those shown on the drawings by the contractor.

1.2.2 Elbows, Vanes etc.

Simple elbows, transformation sections shall be formed with Pittsburg corner seams. Complicated fittings shall be constructed with double corners. Elbows, bends and offset pieces shall have a center line radius of not less than 1.5 times the radial of width of the duct. Turning vanes should be provided at required spacing such that the aspect ratio of each individual elbow formed by vanes shall not be more.

1.2.3 Transformation:

Duct transformation shall be made with a side slope of 10mm to 70mm. Gradual changes shall be used so as to maintain uniform velocities accompanied by decreased turbulence, lower resistance & minimum noise.

1.2.4 Obstructions:

Where ducting has to avoid building structural members, piping, electrical pipes and cables, ducts shall be transformed, divided or curved to one side and a stream lined collar shall be used in all such cases (the reduction in area shall not exceed 20% of the original area) subject to approval of Engineer in charge. Factory fabricated ducts are also acceptable subject to meeting above specification.

1.2.5 Take offs:

All branch take-offs and collars shall be provided with turning vanes. Straightening vanes shall be provided in the collars wherever practicable.

1.2.6 Dampers & Splitters:

Dampers shall be provided in the duct work for proper control and balancing of air distribution. Dampers shall have easily accessible operating mechanism. The operating mechanism shall consist of links, levers and quadrants as required for proper control and setting in a desired position. The position of the handle of Damper operating mechanism shall be clearly visible and it shall indicate the position of the damper in duct. Dampers, splitters and their operating mechanism shall be fabricated of GS sheets of two gauges heavier than duct piece having these fittings and shall be easily accessible through suitable access doors in the ducts.

Dampers shall be installed in duct at all required locations such as chutes, branches etc.

1.2.7 Fire Dampers:

Fire dampers shall be provided in the ducting wherever required as per the local codes. However, fire dampers shall be provided in the ducts passing through fire walls and where the ducts serves more than two floors, fire dampers shall have same fire resistance as that of fire walls, ceiling etc. The fire damper shall be installed in the duct in such a manner that vibration and rattling does not occur due to the passage of air. All fire damper units shall be provided with motor operated switch for operating the damper as and when the fire signals are received from the fire panel. The scope of work includes laying of cable from corresponding fire panel to fire dampers and connection thereof. The item will be measured and paid as per schedule of quantities.

1.2.8 Apparatus and Equipment Connections:

Equipments such as air handling units shall be connected to the duct by means of double canvas sleeve of 15 ounce, woven asbestos cloth connection of at least 150mm long.

Duct sleeves made of 20 gauge thick galvanized sheet shall be used for ducts passing through load bearing walls or partitions. Sleeves shall provide 25 mm clearance all around as per duct or insulated duct. The space between sleeve and duct shall be packed with twisted asbestos.

All the sheet metal plenums required confining the flow of air through filters and fans, shall be fabricated out of 18 gauge galvanized sheet steel, and suitably braced as required. Suitable access doors shall be provided for plenums.

1.2.9 Access Doors:

Hinged or bolted access doors shall be provided in ducting for fire dampers, plenums and any apparatus requiring frequent servicing for inspection. Access doors shall be rigid and shall be provided with air tight rubber gaskets. Insulated ducts shall be provided with insulated doors.

1.2.10 Diffusers & Grilles:

All side wall supply grills shall be double deflection type with both horizontal and vertical vanes being adjustable. Grilles shall be provided with multi-louver damper for volume control with adjustable handle. All return air and exhaust grilles shall have only horizontal louvers. The supply air grills and return air grills shall be on same face and continuous .Supply air ceiling diffuser shall be provided with volume control dampers which can be operated from below.

All the diffusers and grilles shall be of powder coated aluminium. Diffusers and grilles shall be provided with sponge rubber gasket between flanges and wall or ceiling. Samples of grills/ diffusers shall be approved by Engineer-in-charge before installation. The shade of Grills and Diffuser shall match the Building finish and got approved by Engineer–in-charge.

1.2.11 Installation:

The installation of ducting shall conform to standard practice of the trade. Suitable fire resistant frame work for fixing of grilles and diffusers (if required) shall be provided by AC contractor and no separate payment will be made on this account.

The contractor shall upon the award of work prepare detailed shop drawings of ducting for approval by Engineer-in-charge. The drawings shall indicate the exact route of ducting, ducting dimensions, details of splitters, vanes, dampers, fire dampers,

heaters, filters etc. as specified and required. The drawings shall also incorporate cross section indicating beams, obstruction, piping, cables etc. The ducting shall be suitably designed to avoid all obstructions and at the same time utilizing a minimum number of bends/ transformations /divisions etc. Every duct layout drawing shall clearly indicate the location and spacing of supports and hangers.

Ducting over the false ceiling area shall be supported from the ceiling slab or from beams. In no event, the ducting shall be supported from false ceiling hangers, cable trays/ racks, pipe supports or be permitted to rest on the false ceiling. The tenderer shall take suitable precaution while designing the duct route so that the duct routing does not foul with beams/ columns and of other equipments.

All the ducts shall be rigid and shall be adequately supported and braced wherever required with Tees, angles or adequate size to prevent buckling vibration or breathing. The contractor should mention the total quantity of various sizes ducting sheet along with each floor drawing of duct layout.

1.2.12 Insulation:

Duct work shall be insulated as per specification given under insulation.

1.2.13 Testing:

After completion of ducting, the entire system shall be tested for air leakages. The maximum allowable air leakage shall be 10%. On commissioning of the plant, the entire air distribution system shall be balanced to supply the required air quantities to various regions and rooms to maintain the specified inside conditions. The readings of air quantities after final balancing of the system through each diffuser or grill shall be recorded and submitted to the Engineer-in-Charge.

2.0 FACTORY FABRICATED DUCTS AS PER "SMACNA" STANDARDS

2.1 SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal/ aluminum ducts, supply, and installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

2.2 DUCT MATERIAL:

a. Raw Materials:

Galvanizing shall be Class VIII – light coating of zinc, nominal 120gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

2.2.1 Gauges, Bracing By Size of Ducts:

All ducts shall be fabricated from galvanized steel / aluminum of the following thickness, as indicated as below :

For Ducts with external SP upto 250 Pa (25mmWg)

1501 – 1800 mm	22	4 Bolt TDC-H	Nil
1801 – 2100 mm	20	4 Bolt TDC-J	Zeebar stiffener 1-S
2101 – 2700 mm	18	4 Bolt TDC-J	Zeebar stiffener 1-S

'C'-cleat; 'S'-S cleat; 'SS'-Standing S cleat; 'AI' -Angle Iron in mm

*Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

For Round Ducts

Duct diameter	Upto 50 mm Wg static pressure (+ve)	51 – 250 mm Wg static pressure (+ve)	Upto 50 mm Wg static pressure (-ve)

mm	Spiral seam gauge	Longitudinal seam gauge	Spiral seam gauge	Longitudinal seam gauge	Spiral seam gauge	Longitudinal seam gauge
Upto 650	26	24	24	22	24	22
651-900	24	22	22	20	22	20
901-1250	22	20	20	20	20	18
1251-1500	20	18	18	18	18	16
1501-2100	18	16	18	16	16	14

2.2.2 Fabrication Standards & Equipment:

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/ folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges to be machine treated using lockformers, flangers and rollers for turning up edges.

2.2.3 Duct Construction:

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure airtightness.

All ducts up to 75cms width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken

to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS/ 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.

Self adhesive Neoprene rubber/ UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

2.2.4 Installation Practice

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor:

The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.

All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of owner's site representative.

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/ channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

Ducting over furred ceiling shall be supported from the slab above, or from beams after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.

Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.

All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

2.3 DAMPERS:

All dampers shall be of Galvanised iron construction with louver dampers of robust construction and tightly fitted. The design, method of handling, and control shall be suitable for the location and service required.

The damper shall be of opposed blade type. The sheet thickness of blade shall be 0.8 mm and of the frame shall be 1.0 mm.

Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation; control or setting devices shall be made robust, easily operable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Dampers shall be placed in ducts and at every branch of supply air duct connections, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

All the dampers at grille collars shall be of extruded aluminium construction with louver dampers of robust construction and tightly fitted

2.4 SUPPLY AIR DIFFUSERS:

Diffusers shall be of approved make and of Aluminium construction, square/ rectangular in shape with flush fixed pattern or adjustable flow pattern. Diffusers for different spaces shall be selected in consultation with the Engineer-in-charge.

All supply air diffusers shall be equipped with removable key-operated volume control dampers. Anti-smudge ring may be required in specific applications. The outer shell and diffusing assembly shall be made out of powder coated drawn aluminium section respectively.

Jet Diffusers: The jet diffusers shall be made out of drawn sections of aluminium. The diffuser shall have the air control arrangement and the adjustable angle for throw. The diffuser shall be complete with mounting ring, air tight gaskets and fixing arrangement. The jet diffuser shall generally be of circular shape.

2.5 OUTSIDE AIR LOUVERS:

Exhaust/Fresh air louvers of high performance (55% free area) drainable fixed louver type powder coated Aluminium frame and blades. Mullions to be sliding interlock type with integral internal drain. Jamb and mullion drains to be open on front face in order to direct water away from inside of louver. Blades to be one piece extrusions with gutters design to catch and direct water to jumb and mullion drains. Fasteners to be aluminium. Louvers to have framed 13 mm mesh removable mill finish aluminium bird screens.

2.6 TESTING AND BALANCING:

After completion of the installation of the complete air distribution system, all ducts shall be tested for air leaks. Before painting the interiors, air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation.

The entire air distribution system shall be balanced using approved anemometer. Air quantities at the fan discharge and at various outlets shall be identical to, or less than 5 percent in excess of, those specified and quoted. Leakage in each air distribution system shall be within 3 percent so that supply air volume at each fan shall be identical to, or no greater than 3 percent in excess of, the total air quantity measured at all supply outlets served by the fan. Branch duct adjustments shall be made by volume or splitter dampers. Dampers shall be permanently marked after air balance is complete so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted to the Engineer.-in-charge for scrutiny and approval, and six copies of the approved report shall be provided with completion documents.

Note:- Duct shall be fabricated as per SMACNA std. and thickness of duct sheet will be as per IS std.

3.0 STANDARD SPECIFICATION OF FANS:

3.1 GENERAL

Fans shall be of the type, size, arrangement and capacity as indicated in the schedule and/or as shown on the drawings.

Unless specified, fan performance rating data shall be tested accordance with AMCA Standard 210-85(Air Moving and Conditioning Association), ANSI/ASHRAE Standard 51-1985 “Laboratory Methods of Testing Fans for Rating”. Sound ratings shall conform to AMCA Standard 300-85, “Reverberant Room Method for Sound Testing of Fans”.

A computer printout of fan performance rating corresponding to the AMCA licensed data, with corrected ratings for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.

All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with the vibration spectrum analysis shall be attached to the fans.

Fan motors shall comply in all respects with continuous rating in accordance with IEC34 or equivalent. Motor bearings shall be of ball or roller type, grease or lubricant sealed for life. Fan and drive shall be earthed to prevent accumulation of static charge.

Kitchen exhaust fan shall be of Bifurcated Axial or SISW Centrifugal direct or belt driven type. DIDW Centrifugal and Direct Drive Axial Flow Fan where belts or motor are in the air stream are not acceptable.

Fans shall be installed at staircase or lobby where fresh air intake is free from any obstruction and shall be energized only by fire alarm system. Fan shall be of Axial Flow Fan or DIDW Centrifugal Fan. Protective grille at the suction of the fan is required.

Fans for elevated temperature (Smoke Extraction Fans) with components rated for high temperature (250C, 2Hrs) service, with belt drive assemblies exposed to the air stream are not acceptable.

For Smoke Extraction Fans where motor is in the air stream with electrical/ electronic temperature limit switch for motor protecting shall not be used.

Fan should be of G.S.S. , the Steel sheet should be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromated and dry.

If fan is open to atmosphere, Fans shall be with Pure polyester powder coating for minimum thickness of 60 microns.

3.2 AXIAL FLOW FANS (DIRECT DRIVE**)**

Fans shall be licensed to bear the AMCA Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 "Laboratory Method of Testing Fans for Rating" and AMCA 300 "Reverberant Room Method for Sound Testing of fans".

Fan motor base support shall be properly secured (locked and sealed) to the fan housing and be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing. Motor (KW/HP) shall be able to be changed or upgraded at site without changing fan housing or ducting construction.

Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot mounted) and suction/ discharge matching flanges as accessories.

All hubs shall be cast Aluminum alloy (Grade LM2) unless for Smoke Extractor Fans where high temperature (250C/2Hrs) air is expected then Aluminum alloy or steel fan impeller blades are required. Otherwise impeller blade material with Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamid (PAG), to provide self-balancing, anti-static, anti-sparking characteristic is preferable.

Running clearance between blade tips and casing shall not exceed 1% of the impeller diameter, and 2% for smoke spill high temperature fan where mechanical expansion coefficient is different from normal ambient temperature. Fan manufacturer shall provide the fan assembled with the same clearance between blade tips and casing of the tested prototype.

Impellers shall be secured to the drive shaft by a key and keyway. Axial location shall be provided by a collar or shoulder on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the angle setting by setscrews, locking nuts or setting pins.

Fan motor shall be totally enclosed and external terminal box of at least IP55 shall be provided. i)

All fans after assembly shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade. A computer printout with vibration spectrum analysis shall be attached to the fans.

3.3 SMOKE EXTRACTION FAN

Smoke and heat exhaust fans are required to be in compliance with the'BSEN12101-3:2002'. This requires the fan to be subjected to a rated temperature of 250C for a rated duration of 120 minutes.

The Type test report is to be submitted by fan manufacturer & same clearly indicate the make of motor used during the testing and the same make/model of motor should be supplied by the fan manufacture at the site

The fan is required to satisfy the performance criteria specified in 'BSEN12101-3:2002' relating to structural performance, electrical performance and aerodynamic performance throughout the rated duration.

For two-stage counter-rotating Smoke Spill Fan for high-pressure application, each impeller shall be driven by a separate motor within a separate casing.

3.4 PROPELLER FAN

Fans shall be of the ring-mounted type and the blades constructed from heavy gauge metal. An aerodynamically designed bell mouth constructed from heavy gauge metal shall be provided. The fan speed shall not exceed 1400RPM at 50Hz operation.

Propeller fans shall be direct driven type, the motor either a single-phase capacitor start-run or a three-phase squirrel cage induction type. The motor shall have inbuilt inherent protection against overloading. Motor with shaded pole or centrifugal switch type is not acceptable.

Bearings shall be maintenance free permanently lubricated type. Fans shall be complete with wire guards. External grilles, fan chambers and volume control damper shall be provided where indicated in the specification.

3.5 CENTRIFUGAL FANS

Fans, Aerofoil, forward or backward curved, SISW or DIDW, shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 "Laboratory Method of Testing Fans for Rating" and AMCA 300 "Reverberant Room Method for Sound Testing of fans".

All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with vibration spectrum analysis shall be attached to the fans.

Fan should be of G.S.S. , the Steel sheet should be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromated and dry.
Fans housing shall be of an appropriate thickness to prevent vibration and drumming. The fan scroll shall be attached to the side plate by means of continuous lock seam or intermittent spot welding. The wheel and inlet cone shall be aerodynamically designed and constructed to provide maximum performance and efficiency as published by the manufacturer.
Fans must be physically capable of operating safely at every point of rating at or below the "minimum performance" limit for that class as defined in AMCA standard 99-2408-69 "Performance Class of Operating Limits for Centrifugal Fans".
Shafts sizes shall be carefully calculated and designed such that the maximum operating speed (RPM) shall not exceed 75% of the first critical speed. For any application that is not a standard product from catalogue of the fan manufacturer detailed calculation of critical speed characteristic shall be submitted for approval.
Shafts shall be made of carbon steel (C45) machined and polished to tolerance of standard ISO 286-2 - grade g6. Protective coat of anti-rusting shall be applied to all bare surfaces of the shafts at the factory.
Bearings shall be of self-alignment (concentric) type with adaptor sleeve bearing. Bearings of eccentric locking collar with grub screw type are not acceptable. Bearing shall be maintenance free with permanently lubricated sealed ball bearing type. Bearing life shall be at least 75,000 hours based on basic rating life, L10 of ISO 281 standard. Calculation sheet of Bearing Life shall be submitted for approval.
Motor installed shall be of a minimum 130% of the fan power absorbed (Brake horsepower) and shall have sufficient torque available for starting and continuous operation.
Belts and pulleys shall be sized for a minimum 150% of the installed motor horsepower. The belt speed shall not exceed 30m/s. The pulley shall be of Taper Lock SPZ, SPA, SPB or SPC type. Conventional type of pulley is not acceptable. Both fan and motor pulley shall be balanced to the quality grade G.2.5.
Fan outlet velocity shall not exceed 10% of the main duct air velocity designed (0.1" per 100 ft or 1 Pascal per meter duct length). Pressure Loss is as referred to in SMACNA Standard, unless otherwise specified.
Computer printout on fan performance rating corresponding to the AMCA licensed data, with corrected rating for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.
For Air washer Application, fans should have to coat of Pure polyester powder coating. Fans should have Inspection door & Drain plug.

3.6 IN-LINE CENTRIFUGAL DUCT FAN
Fan shall be of SISW / DIDW, forward or backward curved centrifugal, direct driven type.
Casing shall be of Galvanized steel with Oven-baked Pure polyester powder coating. Impeller material shall be either Galvanized Steel or Glass Reinforced Polypropylene.
Motor shall be external power supply 220~240V/50Hz/Single Phase.
Fan should be of G.S.S. , the Steel sheet should be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromated and dry.

4.0 STANDARD SPECIFICATION OF DUCT SUPPORTING SYSTEM:

Wire Hangers shall be used to suspend all static HVAC Air Distribution services.
Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock)at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.
Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002
The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.
Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).
Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.
The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in–line joints should be made in the rope.

Table. 1

Wire Hanger Safe Working Loads		
Size	Minimum breaking load of Wire Rope (kg/lbs)	Working Load Limit (kg/lbs)
No. 1	80 kg/176 lbs	0-10 kg/0-22 lbs
No. 2	260 kg/572 lbs	10-45 kg / 23-100 lbs
No. 3	580 kg/1276 lbs	45-90 kg/101-200 lbs
No. 4	1500 kg/3300 lbs	90-225 kg / 210-495 lbs
No. 5	2160 kg/4752 lbs	225-325 kg/ 496-715 lbs
No. 6	2500 kg/ 5500 lbs	325-500 kg/ 715-1100 lbs

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. Comply with manufacturer's load ratings and recommended installation procedures.Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.
HVAC Supports –Hanger Supports are suitable for: Rectangular duct, Spiral Duct, Oval Duct, Fabric Duct
Ducting Supports:
All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners. In case of PEB structure Loop and Catenary system can be used based on the site conditions
All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method under ducts at no greater than 3000mmcentre, for 3001mm-above appropriate size angle along with neoprene pad in between the duct & MS angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection. Support ducting in accordance with Schedule I at the end of this Section. Any other solution can be used based on manufacturer's recommendation on site conditions after prior approval. In cases of Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided, refer to manufacturer's recommendations.
Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.

Catenary Supports: Refer to manufacturer's recommendations on Catenary supports with C-clip, special care should be taken with tensioning of the wire and angles at which the installation of services are made.
Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.
Refer to manufacturers catalogue and installation guide for further technical information.Comply with manufacturer's load ratings and recommended installation procedures.
Schedule I: Duct Hanger Schedule

For ducts with external SP upto 250 Pa			For ducts with external SP upto 500 Pa		
Maximum Duct Size (mm)	Gauge	Gripple Hanger No.	Maximum Duct Size (mm)	Gauge	Gripple Hanger No.
1 - 750	26	1 or 2	1–600 mm	26	1 or 2
751-1000	26	2	601-750 mm	26	2
1001-1200	24	2 or 3	751-1000 mm	24	2 or 3
1201 - 1500	24	3	1001-1200 mm	22	3 or 4
1501 - 1800	22	3 or 4	1201-1300 mm	20	3 or 4
1801-2100	20	3 or 4	1301-1500 mm	18	4
2101-2700	18	4	1501-1800 mm	18	4
			1801-2100 mm	18	4
			2101-2250 mm	18	4 or 5
			2251-2400 mm	18	4 or 5
			2401-2700 mm	18	4 or 5

Notes: All supports are considered at 2400 mm interval in above table and may vary as per the design but should not be greater than 2400mm.
23 Painting Work
All equipment shall be painted as specified under respective headings. Grilles/ diffusers shall be powder coated as per approved colour matching with interiors. The contractor has to get approval of the quality and colour of paints for all types of painting work.
All pipes for chilled water shall be painted as per standard code of practice and arrows indicating direction of flow of water shall be marked.
Colour scheme for the plant and equipment
Colour scheme for equipment like chilling unit, pumps, AHUs etc shall be as per manufacturer's standard colour scheme.
The scheme of colour code painting of pipe work services for air conditioning installation shall be as per National building code and is indicated below:

Description	Ground colour	Lettering colour	First colour band
Chilled water piping	Sea Green	Black	Black
Central heating piping Below 60 deg C	Sea Green	Black	Canary Yeliow
Central heating piping 60 deg C to 100 deg C	Sea Green	Black	Dark Violet
Drain pipe	Black	White	
Vents	White	Black	
Valves and pipe line fittings	White with black handles	Black	
Belt guard	Black & Yellow diagonal strips		
Machine Bases, Inertia Bases and Plinth	Charcoal Grey		
Steel Support	Black		
Pump sets	Battle Ship Grey		
Direction of flow of water	White arrows		
Electrical Panel/ Sub Panel/ Remore Control Console	Light grey or any approved colour		
Cable Trays & Duct Support	Black		

iii. Colour bands shall be 150mm wide, superimposed on ground colour to distinguish type and condition of fluids. The spacing of band shall not exceed 4.0m.

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow identified as flow.

END OF SECTION

5.0 TESTING AND BALANCING

5.1Testing and Balancing
5.2 General
Submittal Requirements
Submit the following information to the Consultants:
List of proposed instruments, meters and devices to be used for this project.
Outline of methods proposed for testing, adjusting and balancing.
The name and qualifications of the testing and commissioning engineer who will certify the report and the names and qualifications of all personnel who will be assigned to this project. Use of other personnel will be grounds for contract termination.
Note: The Client/Consultants reserves the right to request an independent test and balance Specialist or Agency to be engaged by the EPC contractor if it feels the proposed Engineer and Testing and Balancing Team personnel are lacking qualification and necessary instruments required for the intended job.
A listing of project references including project names, Engineer, EPC contractor and Owner references with telephone numbers and contact persons.
Work Included
Comply with - General Specifications and HVAC General Provisions and all documents referred to therein.
Provide all labour, materials, products, equipment and services to test, adjust and balance all air and refrigerant systems to verify conformance to specified quantities and to the design intent of the mechanical system.
Make final adjustments to best suit building conditions prior to and immediately after Substantial Performance. Include overtime costs for conducting final balance in unoccupied hours.
For specified test openings, refer to Section -"Sheet Metal". Provide additional openings required for pitot tube traverses. After balancing, close openings with removable gasketed plugs.
Provide data register as required.
Provide system report.
5.3 Products
Supply and Turnover to Owner One (1) Complete Set of Testing and Balancing Instruments as Follows
Air balancing instrument – "Short ridge" air velometer set complete with measuring hoods and accessories similar to the following:
Air Data Multi meter complete with Airflow Measuring base assembly, battery charger, carrying case.
Fire top kit (2"x2", 2"x4", 1"x5", 3"x3")
Pilot tube 18" long
Temp probe (ADT 442")
Temperature netractile cord. 6' long (TRC-16) 6. Temperature extension wand, 19" long (TEW-19)
Two A-303 static pressure tips.
Neoprene tubing set, two 5" long and one 10" long.
Self-Balanced Dampers (Constant Air Flow Regulators) And Grilles
In lieu of manual balancing dampers, self-balanced dampers or constant airflow regulators and grilles can be provided for certain applications subject Engineer's approval. With airflow controlled at pre-set value, these dampers eliminate adjustments/balancing on site and greatly facilitate the task of the Balancing EPC contractor.
19.3 Execution
Calibration of Testing Equipment
Calibrate equipment immediately prior to commencement of the work and check at regular intervals to ensure that calibration is maintained. Provide calibration certificate when requested by Consultants showing dates and method of calibration.
Verify permanently installed meters and devices by calculation and calibration or by independent measurement of the same flowing medium with calibrated devices.
Preparation Work
Before starting the balancing, the EPC contractor shall make sure that each operation listed below, whichever is applicable, has been satisfactorily completed. Physical installation of air and piping systems as specified.

Examine approved submittal data of system and equipment.
Examine design data, system descriptions, statement of design conditions and system output and philosophies about system and equipment controls.
Examine system and equipment installations to verify that they are completed and that commissioning specified in Section - "Commissioning" have been performed.
Examine ACMV system and equipment installations to verify that indicated balancing devices such test ports, gauge cocks, thermometer wells, flow control devices, balancing valves and fittings, manual volume control dampers are properly installed and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
Report deficiencies discovered before and during testing and balancing procedures.
Pressure and leak testing of air and piping systems as specified. All testing will be witnessed by the Consultants -In-Charge or its representative/ Client.
Air plenum ceilings have been properly constructed and sealed.
Equipment is in operable condition, with all accessories installed.
Proper thermal overload protection is in place for electrical equipment.
Linkages and equipment have been serviced and lubricated and tested for proper operation.
Duct systems are clean of debris.
Fire and volume dampers are in place and open.
checked for misalignment, imbalance, excess vibration, improper rotation or motor overload. Correct all deficiencies prior to balancing.
Prepare procedures for testing and balancing for all systems under.

Procedures for Balancing of Air Systems
Perform the required number of distribution air balances and adjust in order to obtain required terminal airflows with plus/minus (+/-) 5%. Perform at least one additional fan capacity test as described above, after the distribution balance has been completed.
Provide air flow measurements to assist in set-up of supply and return fan tracking controls.
Where similar or typical conditions exist, submit for review, simplified checking procedures for portions of the balancing work. These procedures may be accepted if proposed procedures do not decrease the quality of the air balance.
Testing Requirements
General
Carry out all commissioning and testing necessary for the safe, reliable and satisfactory operation of the system and equipment installed.
The Works shall be commissioned and tested in accordance with manufacturer's instructions, the appropriate ASHRAE/ IS commissioning codes, local Government requirements, and this Specification.
At least one month prior to testing or commissioning any system, furnish the following information for each system or process to the Consultants for review.
Testing procedure and details as well as the relevant report forms to the Consultants for approval.
Type of instruments to be used
Manufacturer of instrument.
Calibration methods for instruments.
Operating instructions for instruments.
Accuracy and tolerances of instruments.
Complete schedule and programme of all testing and commissioning activities
All instruments and labour necessary for testing and commissioning shall be provided by the EPC contractor.
All instruments shall have been recalibrated within six months of the start of commissioning or testing. Calibration of all instruments shall be certified by the instrument manufacturers or an approved calibration agency.
Should the results of any test show that any plant, system or equipment fails to perform to the efficiencies or duties as given in this Specification, the EPC contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performances be obtained.

Should it be necessary for the EPC contractor to modify or replace any item of plant as described above, he shall be responsible for the cost for making good of any damage or deterioration to the building or other services consequent on such modifications.

Allow in the Contract Price cost for returning to site during the first year of operation from the date of Completion Certificate issued by the Engineer to test systems under maximum design conditions. Be aware that such tests may need to be carried out after normal office hours as required by the employer.

All equipment site testing and commissioning shall be carried out by manufacturer's qualified field engineers.

Factory Tests:

The following items of equipment shall be tested at the manufacturer's works or elsewhere as appropriate prior to installation. In all cases, test certificates shall be submitted in triplicate.

Fan

Type-test' Certificates showing fan characteristic curves, and Type Test Certificates for sound power levels.

Electric Motors

Type-test' Certificates. For motors of 40 kW output and above, routine individual test certificates shall also be submitted.

Starters and Control Gear

Type-test' Certificates. For control panels as a whole, routine (individual) high voltage test.

All instruments, test equipment and consumable materials, and expenses incurred including certification by an independent authority shall be included in the Contract.

The more important measurements required shall be: Wet Bulb temperature, cold/hot water temperature, circulating / makeup / blow-down water flow rate, tower pumping head, fan driver power input, and noise levels.

Any tower found not up to performance shall be rejected and the EPC contractor shall provide additional features to enhance its performance at his own expense before another acceptance test shall be carried out. Failing which the EPC contractor shall replace the equipment with other brands complying to the above requirements.

Fan Equipment & Ductwork

Air flow at each supply and exhaust duct, and at each supply, return and exhaust air grille and diffuser.

Pressure differentials across the staircases, fire lift lobby, and lift shafts o confirm achievement of desired pressure levels.

All fan and motor speeds.

Starting and operating current for each motor.

Noise and vibration levels in plant room and occupied space.

The following ductwork system shall be tested for leakage rate in accordance with ASHRA SMACNA requirements:

All medium and high velocity ductwork

All pressurization, ventilation & smoke extraction system ductwork

All smoke purge system ductwork a. Pipe Systems

All the commissioning procedures shall comply with those set out in the current edition of the ASHRAE Standard or CIBSE Guide Commissioning Code Series W.

All refrigerant pipe systems shall be flushed, vacuumed and pressure tested to specified test pressures recommended by the manufacturer. The pressure shall be maintained for a period not less than 10 hours within ±2%

Where any section of pipe work or equipment of the plant is unable to withstand the maximum pipe work test pressure, it shall be isolated during the pipe work tests, then, that section of pipe work or equipment shall be re-tested at the appropriate test pressure.

All Unit Condensate Drain piping and U-traps shall be thoroughly tested with water to establish proper flow direction and for any leaks in the installed piping, before final commissioning.

The following data shall be recorded on the commissioning sheets:

Supply / exhaust fans motor speed

Air Flow rates & Total pressures as checked against fan curves and data.

Starting and operating current of each fan motor

Noise and vibration level of fans and AC Units

Control System

Include all thermostatic and automatic controls to be commissioned and tested by the control manufacturers Engineer. Generally, the commissioning procedures shall comply with that set out in the current edition of ASHRAE Standards or the CIBSE Guide Commissioning Code Series C.

Calibrate all thermostats and pressure stats, set the modulating range and set points on all units to ensure that operating conditions are correct.

Interlocking circuit and safety devices shall be tested to ensure safety operation of the plant.

Other site tests as specified in the Control Section of this Specification shall also be performed.

Miscellaneous Measurement and Testing

Room temperature, pressurization levels and noise level shall be measured to ensure design conditions are achieved. Measuring instruments shall be located 1500 mm above floor level at points away from the influence of draughts or hot or cold surfaces. Such measurements shall not be carried out when weather or other environmental conditions are likely to cause undue influence to the results.

Sound and vibration testing shall be carried out to ensure that equipment are operating within the specified maximum sound and vibration levels and that there is no transmission of objectionable vibration or through the building structure. Sound levels shall be measured with and without the plant in operation.

j Final Adjustments and Commissioning:

When the entire installation works are completed and all the above checking and testing have been properly carried out, the EPC contractor shall set to work, regulate and calibrate the entire installation. Particular attention shall be paid to the following:

All fire dampers, volume control dampers, switches, controls, etc. are regulated to operate properly in accordance with the specified performance. All valves shall be able to be shut off totally at the maximum anticipated system working pressure.

All equipment are silent and meeting the specified noise and vibration levels.

All instruments are correctly calibrated and read accurately.

All fan pressurization and ventilation systems are operated properly and are able to deliver the correct air-flow rate to each individual space.

All control systems are functioning correctly and are properly sequenced, interlocked, and interfaced with other services.

All major plant to be fully commissioned by the respective Manufacturer's qualified field testing and commissioning engineers.

Be aware that the commissioning may need to be carried out after the Completion Certificate is issued and after normally office hours, as required by the Employer. k Handing Over:

The following procedure shall be adopted prior to handing over the installation:

All preliminary testing, checking, adjusting and balancing of the installation shall be carried out before forwarding notification that the installation is considered to have reached Practical Completion.

After inspection by the Consultants, the plant shall be finally commissioned and Installation prior to handover to the Employer. Manuals together with as-built drawings shall be provided as specified.

Completion Certificate will be issued only after the plant has been inspected and approved and the above requirements fulfilled.

4. Reports

Submit Fortnightly progress reports during the work to the Client. Include preliminary recommendations, and advise Consultants of any situation which may adversely affect end result of balancing.

Submit four copies of the final type written report at the completion of the work. Print reports on letter quality paper and enclose each in hard cover binders.

Include the following in each report:

Cover sheet identifying project name, address, Owner name and EPC contractor name.

Balancing company, address, and name of balancing technician, date and time of test, description of test equipment and ambient conditions at time of test.

Complete equipment identification data and location, including manufacturer and model, size, arrangement, discharge, class, motor type, kW, voltage, phase, frequency and FLA, belt size/model number and sheave size.

Detailed summary of velocity traverses and calculated air quantities for each fan.

Actual fan and system curves for each fan showing plotted design and field condition.

Rated and actual motor current, in amperes, of every motor at full load conditions.
Schematics for all systems with all terminals identified.
Provide General Arrangement drawings of all major Equipment's.
Provide Detailed Schematic control and Shop drawings of Electrical Panels.
Provide Detailed Catalogues of all equipment's.
Provide separate test forms for each air and water system.
Submit with the report, a summary listing of recommendations for Consultants's review
Certify all reports by the Balancing Engineer and balancing technician before submitting for Consultants's review.

END OF SECTION

6.0 COMMISSIONING

6.1 Commissioning
6.2 General
Work Included Comply with requirements in Schedule of Equipment and Section "HVAC GENERAL PROVISIONS".
Provide all services, materials and labour required to fully commission the mechanical systems in accordance with this Section of the Specification.
Manufacturer's technical personnel shall be involved in the commissioning process of the following equipment and system on site. All associated cost shall be included in the Contract.
Fan
Sheet metal duct work
Grill & Diffuser

The test and commissioning shall consist of primary check of the installation correctness and final check and verification of the system function and operational performance.
Coordination
Meet the requirements of the General Instructions.
Coordinate the work of this Section with all other Divisions to ensure complete and operational mechanical systems at completion of this work.
Appoint a single person as Commissioning Engineer who shall be responsible for progressing the commissioning activities of each Division 12 trade.
Review the design intent of the project and the intended operation of systems with the Consultants before proceeding with commissioning.
Quality Assurance
Meet ASHRAE Standard 1-1996 or equivalent IS Guideline for Commissioning of HVAC Systems.
If in the Consultants /Owner's opinion that the qualifications of the EPC contractor commissioning team is not acceptable, the EPC contractor shall engage an independent Testing and Commissioning Specialist to perform all testing and commissioning works on his behalf. Supply the following details regarding the proposed firm for approval:
Principle representative and qualifications
Proposed personnel and relevant project experience
Previous similar assignments and references
Scope of work to be undertaken
Company resources and equipment
Use of an independent testing and commissioning specialist shall not relieve the EPC contractor obligation to name one of his own employees as the person responsible for progressing commissioning, i.e. the Commissioning Engineer.
Supply the name, qualifications and experience of the proposed Commissioning Engineer for approval. Selection shall be subject to review and the approval of the Consultants. Supply alternative person(s) when requested by Consultants.
The Consultants may, at his discretion, attend and advise in the commissioning process. Meet Engineer's requirements.
Hold and attend regular meetings during the commissioning process. Prepare detailed progress reports to coincide with regular commissioning meetings. Coordinate, prepare, and issue of minutes for each meeting to be circulated to each involved trade, the Consultants and the Engineer representative(s). Minutes shall highlight action items.

6.3 Products

Schedules and Completion of Installation Of Systems Submit, within 8 days from the commencement of the Contract a detailed and comprehensive installation completion/start-up/testing schedule, identifying all trades and Contractors to be involved. Update the schedule and resubmit for review, on a monthly basis, during the course of commissioning. If found to be unacceptable, revise the schedule and the construction forces to suit the reviewed schedule. This schedule shall include, but is not limited to the following items:
Electrical service connections.
Installation, leak testing and cleaning of duct systems.
Installation and hydraulic testing of all pipe systems.

Control system wiring.
Air and water balancing.
Equipment Contractors pre-start checkout of the equipment installations, including controls.
Start-up of various pieces of equipment and systems.
Operational testing of system components.
Performance testing of equipment and systems.
Acceptance testing of equipment installations and system, by authorities having jurisdiction and Owner's insurance company.
Troubleshooting.
Calibration of controls and point checkout.
Submittal of completed equipment and system checkout sheets
Demonstration of systems and equipment
Maintenance manual preparation and submittal
Operator training program
Record documentation submittal
Record Documentation
Prepare record documentation for each equipment installation covering:
Equipment identification and Contractor
Shop Drawing submittal, review, production release, and delivery dates
Dates for completion of all work required to prepare for equipment installation
Dates for equipment installation, Contractor pre-start checkout and system availability for startup.
Dates for equipment start-up, performance testing, proposal for temporary use, acceptance testing, demonstration, turnover and warranty start/finish
Submit proposed record sheets and procedures to Consultants for review, when requested.
List all specialist personnel and equipment required for the test and ensure that these are available by the test date.
Provide documentation of the commissioning process for inclusion into the maintenance manuals. These are to include checkout sheets, equipment data sheets, start-up certificates from Contractors involved in start-up, documentation concerning demonstration to the Owner. Include all record and result sheets form commissioning tests.
Maintain a log of key operating parameters, problems encountered, solutions employed and verification of effectiveness of solutions. Include log in maintenance manuals.
Start-up
Coordinate and supervise the start-up of the various pieces of equipment and systems. Utilize the start-up services of the manufacturer's representative. Ensure that the equipment is operating in a satisfactory manner. Check the following items:
Direction of rotation
Grease and lubricants
Noise, if deemed to be a problem
Seals
Alignment of fan drives by a millwright
Piping connections and safeties
Electrical amp draw, starting inrush current and trip/heater settings
Performance of all plant and equipment in accordance with the manufacturers' ratings.
Troubleshooting
Resolve inter-Division coordination problems.
Where problems become apparent during the commissioning process, identify and resolve these problems. The basic functions in troubleshooting are: 1. What - identification and definition of the problem
Why - determination and evaluation of the causes
When - determine the time available or constraints to resolve the problem
Involve the Consultants in the review of the problem and proposed resolution
Coordinate remedial actions with the appropriate parties
Evaluate the effectiveness of the remedial actions
Record the problem, cause, remedial actions and results

Operation and Testing

Test the operation of the individual components and systems. Go through each step of the sequence of operation and verify that each component operates correctly. Direct and ensure that all other division work trades involved make the required changes and adjustments to effect the proper operation of all components and systems. Meet commissioning test requirements. Document operation and testing.

Carry out operational tests for the current season and simulate operation of summer and intermediate seasons.

Demonstration

Demonstrate to the Consultants and Owner's representatives the proper operation of all equipment and systems supplied under this Division. Demonstrations shall occur only after the operation and testing has been successfully completed. Ensure that equipment Contractors participate in the demonstration as required.

6.4 Execution Commissioning Tests ACMV System:

Verify readings, calibration and set-up of sensors and equipment, including:

1. Temperature sensors
2. Air flow switches (If used).

Status switches (If used).

Pressure sensor, gauges and gauge connection utilization

Control damper positioning, including tightness when closed and full open/balance position

Verify correct sensors are reporting accurately to the distributed field panels and operator workstation.

Operate each major equipment's such as AC Split units & fans. Verify and correct the following if required:

Correct open/close and modulation procedures with valves and dampers

Stable operation of controls under normal conditions and with changes in air/refrigerant/on/off conditions

Trend logs operation indication 4. Piping, sensor and unit installation

Filters for return air.

Drain pan operation and trap priming.

Variable speed drive frequency and pump / fan speed.

Verify duct cleaning, air balancing and air pattern adjustments. Supply air grille, diffuser air flow measurement.

Verify access to each fire damper.

Commission test of all ACMV equipment such as Fans and AC Split Units, etc as per manufacturer's recommendations.

Measure and verify resultant noise level of every room, corridors, apartment unit, Basement and lobby.

Carry out smoke test to verify air flow pattern and activate the engineered smoke control system and verify the system performance.

Verify staircase pressurization system performance and air balancing to maintain the required pressure differential between stairs well and vestibule.

Same procedure as above for the fire lift lobby pressurization system and lift well pressurization.

System operation tests including normal power supply scenario and simulating power failure scenario to demonstrate stability of control equipment with start-up power surge and controls system recovery.

Verify the ACMV system interfacing and integration with Fire alarm system and proper performance / actuation of the pressurization systems in case of fire alarm.

Post Completion Performance Visits

Visit the site and the Owner's representative each month after project completion for a minimum period of two days until the end of the project warranty period.

Review the operation of the system.

Correct any operating problems, if problem is related to warranty issues.

Prepare a report for inclusion in the Operating Manuals of the problems and issues that have arisen and the corrective action(s) recommended and implemented.

END OF SECTION

7 SCHEDULE OF TECHNICAL DATA (TO BE FILLED BY CONTRACTOR DURING WORK EXECUTION)

7.1 Schedule of Technical Data(To be Filled by Contractor)

7.2 Axial Fans

Make and Model	
Type	—
- Confirming to:	
Air Inlet	Single/double
Air Quantity at design speed	M3/Hr.
Outlet velocity	M/Sec.
Static Pressure	MMWG
Velocity Pressure	MMWG
Total Pressure	MMWG
Wheel Diameter	MM
Rated RPM	RPM
BKW	KW
Rated KW of Motor	KW
Motor Conforming to:	
Motor speed	RPM
Type of Motor	—
Noise Levels of complete unit at a distance of 1m.	dB
Material of Construction:	
-Blades	—
-Housing	—
Overall Dimensions.	MxMxM (H)
Accessories offered.	—

7.3 AIR WASHERS

a) Make of AWS & fan

b) Type of fan

c) No of fans per AWS

d) Capacity of each fan in CMH

e) BKW of each fan

f) Motor HP of fan

g) No of pump in each AWS

h) HP of each pump

i) Make of cooling media

j) Face velocity across media

k) Total area of media

l) Material & Size of filters

m) Area of filters

n) Efficiency & filtration capacity Of filters

o) Efficiency of AWS

Material of casing of AWS
Thickness of casing of AWS :

7.4 PROPELLER FANS

Make and Model
Air Quantity at design speed M3/Hr.
Outlet velocity M/Sec.
Static Pressure MMWG

Blade Diameter MM

Rated RPM RPM

Rated KW of Motor	KW
Motor Conforming to:	
Motor speed	RPM
Type of Motor	—
Whether Balanced	
Noise Levels of complete unit at a distance of 1m.	dB
Material of Construction:	
- TYPE	—
- MAKE	—
Overall Dimensions.	MxMxM (H)
Accessories offered.	—

7.5 INLINE FANS

Make and Model	
Air Quantity at design speed	M3/Hr.
Outlet velocity	M/Sec.
Static Pressure	MMWG
Wheel Diameter	MM
Rated RPM	RPM
Motor Conforming to:	
Motor speed	RPM
Type of Motor	—
Noise Levels of complete unit at a distance of 1m.	dB

Material of Construction:

Bearings:

Overall Dimensions. MxMxM (H)

Accessories offered. —

Galvanised Steel Sheets
Make
Thickness/Gage
Class of Galvanizing
Grilles / Diffusers / Dampers Make material and gauge of the following:
Fire damper, rating, make of damper motor
Smoke damper, rating, make of damper motor
Grilles/Diffuser
Slot Diffuser
Duct Damper
FA Damper
Access Panel.
Insulation
Manufacturer
Duct acoustic lining material & density
Duct insulation material & density
Pipe insulation material & density
Valve
Type and make of water valves
Butterfly valves with PN rating —
Balancing valves with PN rating —
Gate Valves with PN rating —
Non-Return Valves with PN rating —
Thickness

8 NOISE & VIBRATION CONTROL

Scope of Work

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

Standards

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated:

BS 4718: 1971	Methods of Test of Silencers for Air Distribution Systems
BS 2750:	Laboratory and Field Measurement of Airborne Sound
Parts 1-9:1980	Insulation of Various Building Elements
	Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings
BS 3638: 1987	Methods of Measurement of Sound Adsorption in a Reverberation Room
BS 4773:	Acoustic Testing.
Part 2: 1976	
BS 4856:	Acoustic performance without additional ducting of forced
Part 2: 1976	fan convection equipment.
Part 5: 1976	Acoustic performance with additional ducting of forced fan convection equipment
BS 4857:	Acoustic Testing and Rating of High Pressure Terminal
Par 2:1978 (1983)	Reheat Units.
BS 4954:	Acoustic Testing and Rating of Induction Units.
Par 2:1978 (1987)	
BS 5643:	1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms

General

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission generated by moving plant and equipment to achieve acceptable limits for occupied areas. In addition to the noise level criteria particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

All moving plant / equipment shall be statically and dynamically balanced at manufacturers works and certificates issued.

The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.

Where duct work and pipe work services pass through walls, floors and ceilings, or wherever supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimise the outbreak of noise from plant rooms.

The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.

Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.

All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.

All resilient acoustic absorbing materials shall be non flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

Where practicable, attenuators shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described. Where this is not feasible, the exposed surface of the duct work between the attenuators and the wall subjected to noise infiltration shall be acoustically clad as specified.

Ambient noise from cooling tower also shall be assessed to determine the suitable attenuators that can reduce the noise so as not affecting the adjoining public area.

Sound Attenuators

Attenuators shall be provided in ducts in accordance with acceptable noise level criteria. Attenuators shall be constructed from high quality pre-galvanised steel sheet casings with lock formed joints along the casing length. Angle iron cross jointing flanges shall be fitted to silencer casings, drilled as required and finished with red oxide primer paint. Acoustic splitters shall be formed by chancel section pre-galvanised sheet steel framework retaining acoustic fill of a density to attain the required performance. Splitters shall have round nose ends to give smooth entry and exit conditions to minimise air pressure drops. The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanized sheet steel. All attenuators shall be selected against a maximum allowable air pressure drop of 100 Pa.

It will be the responsibility of the AC Contractor at the time of placing orders for fan equipment to obtain from the manufacturers, certified sound power levels to enable the selected duct silencers to be checked against the original design information, prior to orders being placed.

Anti-vibration Mountings

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels.

Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections.

Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti-vibration mountings, or suspended using spring loaded hangers to suite the application.

Centrifugal pumps shall be mounted on inertia bases consisting of reinforced concrete sub-base, anti-vibration mountings and concrete filled steel upper plinth. The AC Contractor shall be responsible for providing the steel upper plinth and mountings.

Pipe work connections to circulating pumps, chillers, cooler coils and other heat exchanger equipment shall be made with flexible connections as per piping Specifications.

The construction of the anti-vibration mountings shall generally comply with the following: -

Enclosed Spring Mounting (Caged or Restrained Springs)

Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built- in leveling device.

The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound.

The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

Mountings incorporating snobbery of restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable of being adjusted to have no significant effect during the normal running of the isolated machine.

The manufacturers shall provide restrained isolator on chillers subject to approval.
Open Spring Mountings

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

Neoprene-in-Shear Mountings

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a leveling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

PROPOSED CONSTRUCTION OF POLO MARKET, SHILLONG, MEGHALAYA

LIST OF APPROVED MAKES / BRANDS

S. No	Material	Approved Makes/Brands		
CIVIL/INTERIOR WORKS				
1	Ordinary Portland Cement / PortlandPozzolona Cement	ACC	Ultratech	J. K Cement
		Lafarge	Ambuja Cement	
2	White Cement	Birla Cement	J. K White	Lafarge
3	Ready Mixed Concrete	ACC	L&T	JK Cement
		Unitech	Grasim	
4	Reinforcement Steel (TMT – Fe500/Fe 500D)	SAIL	Tata Steel Ltd	RINL
5	Structural Steel/M.S. Tube	TATA	RINL	SAIL
		TISCO		
6	Anti-Termite Treatment	Pest Control India Ltd	Pest Con India	Pest Control Incorporated
		Premier Pest Control Pvt. Ltd.	Any permanent members of IPCA as approved by Engr-in-Charge	
7	Plasticizer, Super Plasticizer, Admixtures, Other construction chemicals	CICO	Fosroc	BASF
WATERPROOFING				
8	Integral Waterproofing Crystalline Admixture	Sunanda Chemical	Xypex Chemical	Penetron
9	Polyurethane,Liquid Applied Waterproofing Membrane	Sunanda Chemical	BASF	SOPREMA
		MAPEI		
10	Liquid Applied , Acrylic Elastomeric Membrane	BASF	SIKA	FOSROC
		Sunanda Chemical		
11	Waterproofing Self Adhesive (HDPE) Membrane	Sunanda Chemical	STP	FOSROC
		BASF		
12	SBS Membrane	BASF	Sunanda Chemical	FOSROC
		SIKA		
PAINTS AND COATING				
13	Anti Corrosive Paint for Structural SteelIntumescent Coating	Akzonobal	BASF	MAPEI
		Sunanda Chemical		

14	Phenolic Epoxy Paint	Akzonobal	-	HILTI
15	Exterior Wall Heat Insulation , UV Resistance Paint	Sunanda Chemical	BASF	FOSROC
16	Texture Paint	FOSROC	Sunanda Chemical	Akzonobal
		Jotun	Asian	
FLOORING AND EPOXY COATING				
17	Polyurethane Concrete Flooring	Sunanda Chemical	BASF	MAPEI
		Pidilite		
18	Food Grade Epoxy Coating	MAPEI	STP	Sunanda Chemical
		BASF		
19	Anti Static Flooring	Sunanda Chemical	STP	FOSROC
		MAPEI	BASF	
GROUTS				
20	Shrinkage Compensating Grout Admixture	FOSROC	MAPEI	Sunanda Chemical
		BASF		
21	Cementitious Grout	FOSROC	ARDEXENDURA	Sunanda Chemical
		SIKKA		
22	Epoxy Grout	Sunanda Chemical	FOSROC	STP
		BASF		
23	Polycarbonate Sheet	Palram	Gallina	Danpalon
24	Rebarring Chemical	Hilti	3M India	
25	Fire Sealant	Hilti	3M India	Fischer
26	Parallel Threaded Couplers (Compliant to IS:16172:2014)	Dextra	Halfen Moment	G-Tech
27	Extruded Polysterene Board	STP	Supreme	Ownes corning
		Shalimar		
28	AAC Block	Aerocon	Finecrete	JK
29	AAC Mortar	Birla Aerocon	Ultratech	JK
30	Moisture Resistant Board	Saint Gobin	Gyprox	USG Boral
31	Veneered Particle Board	Archidply	Duro	Action TESA
32	Laminated Particle Board / Laminates	Merino	Greenlam	Century
33	MDF	Action Tesa	Greenply	Archidply
		Greenpanel		
34	PRE Laminate MDF	Action Tesa	Green	Archidply
		Greenpanel		
35	Metalic Laminates	Merino	Century	Metlam
36	Flush door shutters	Duro	Greenpanel	Merino
		Century	Archidply	
37	Hardware for Fire Check Door	Dorma	Becker Fire Solution	Dorset
38	Plywood / Veneer/Laminate	Merino	Century	Century
		Archidply	Duro	Greenpanel
39	Expansion Joint – Modular	C.S	Herculus	Z-Tech
		Vexcolt	Fischer	

40	Aluminium Bldg. Expansion Joint	Vexcolt	Z-Tech India	C/S Expansion Joint
41	Polyster Powder Coating Paints	Nerolac	Berger	Akzonobel
42	Wall Putty	Birla Wall Care	JK White	Asian Paints
43	Oil Bound Washable Distemper	Asian Paints	Nerolac	Berger
		Ultratech	Dulux	
44	Acrylic Distemper	Asian Paints	Nerolac	Berger
		Ultratech	Dulux	
45	Premium Acrylic Emulsion paints	Asian Paints	Nerolac	Berger
		Ultratech	Dulux	
46	Cement Primer	BP White (Berger)	Decoprime WT (Asian)	Akzonobel (Dulux)
		Nerolac		
47	Cement Paint	Snowcem Plus	Berger (Durocem Extra)	Nerolac (Nerocem With Titanium)
		Asian	Ultratech	
48	Steel /Wood Primer	Akzonobel (Dulux)	Nerolac	Asian Paints
		Berger	-	First quality of ICI
49	Textured Exterior Paint	Spectrum	Asian (Apex Ultima)	Nerolac Kansai (Excel)
		-		
		Berger	-	Unilite heritage
50	Synthetic Enamel Paint	Akzonobel (Dulux)	Asian (Apcolite)	-
		Berger	First quality of ICI	Johnson &Nicholsan
51	Epoxy Paint	Pidilite	-	FOSROC
		Sikka	Berger	Cico
		-	-	-
52	Heat Resistant Tiles	Swastik	Thermax	
53	Gypsum Plaster	Ferrous Crete	Elite (90)	Ultratech
54	Pre-Cast GRC Jali	Unistone	Dalal Tiles Industries	Ecovision
55	Stainless Steel	Salem Steel	Jindal Alloys	SAIL
56	Stainless Steel bolts, Washers and Nuts	Kundan	Puja	Atul
57	Stainless Steel Friction Stay	Earl Bihari	Securistyle	EBCO
58	Stainless Steel Pressure Plate Screws	Kundan	Puja	Atul
59	Stainless Steel Screw for Fabrication and fixing of Windows	Kundan	Puja	Atul
60	Welding Electrodes	Advani	Oerlikon	Modi
		L & T	Ici	
61	Stainless Steel Hardware	Dorma	Kich	Ozone
		Godrej	Dorset	
62	False Ceiling – Gypsum	Saint Gobain	USG Boral	Lindner

		India Gypsum	Lafarge	
63	False Ceiling – Metal	Amstrong	Hunter Douglus	USG Boral
64	Gyp Board	Saint Gobain	USG Boral	Lindner
		Boral Gypsum	Lafarge	India Gypsum
65	False Ceiling – Mineral fibre	Armstrong	AMF	USG Boral
		Saintgobain	Hunter Douglas	
66	False Ceiling – Aluminium	Armstrong	Durlum	Hunter Douglas
67	Curtain Rod/Drapery Rod	Vista work	Mac Décor	Hunter Douglas
68	Fabric Blinds	Hunter Douglas	Mac	Vista
69	Facade Tiles	Clayton	Terreal	Hunter Douglus
		Faveton		
70	Expanded Metal Mesh Panels	Fils&Italfim	Expanded Metal Mesh company	Harsons Green
71	Fibre Cement Panels	Equitone "Mineralis"	Swiss pearl	FibreC by Rieder
72	Zinc Panels	VM Zinc	Halcor	Leqsa
		Cinkarna		
FLOORINGS				
73	Mosaic / chequered Tiles	Unistone	NITCO	Unitile
74	Ceramic tiles / Glazed Tiles	Kajaria	Somany	NITCO
75	Vitrified Tiles (Antiskid / Matt / Glazed)	Somany	Kajaria	NITCO
76	Terrazzo Tiles	NITCO	Unistone	Hindustan
77	Cement Concrete Tiles Designer Tiles	Unistone	Ultra	Eurocon
78	Laminated Wooden Flooring	Krono	Pergo	Harro
		Berry	Armstrong	
79	Vinyl Flooring	Tarkett	Armstrong	Polyfloor
80	Carpet Flooring (Tiles & Rolls)	Modulyss	Forbo	Corus
		Shanhua	Heritage	
81	Paver Block & Kerb Stone	NITCO	Unitile	Ultra
		KK Manholes	Unistone	
82	Dash / Anchoring Fasteners	Hilti	Fisher	Bosch
		-	Anchor	
83	Floor hardener	Ironite	Fosroc	Hardonite
84	Composit Marble / Granite / Engineered Stone	Asian	Johnson	Kalinga
85	Water Based Melamine Polish	Asian	Pidilite	ICI Dulux
		Berger		
86	Fire Retradant Paint	Asian	Berger	Shalimar
		Viper FRS 881	Nullifire	
87	Clamp System For Dry Stone Cladding	Hilti	Fischer	Bosch
88	Polysulphide Sealant	Fosroc	Wacker	BASF
		Dow Corning		
89	Adhesive for Wood Work	Dunlop	Fevicol	Vamicol
		Araldite	Pidilite	
90	Rolling Shutter	Rama/	Prakash	

91	Venetian Blinds	Mac Décor	Vista	Hunter Douglas
92	Built In Furniture	Wipro	Blowplast	Godrej
		Featherlite	Geeken	
93	Maintenance Equipment, (Ladders, Façade Tolleys Etc.)	Shri Modi (Gujrat)	M/S. Natraj (Pune)	L & T
94	Building Signage/ Fire Signages	Hindustan Signage	Signsutra	WRS Enterprises
95	Glass Wool	Rockwool	UP Twiga	Lioyd Insulation
96	Glass Fibre Acoustical Ceiling Tile	Anutone	Decosonic	Armstrong
97	Acoustic Wooden Perforated Slat	Anutone	Armstrong	Decosonic
98	Acoustical Fabric (With Glasswood) Wall Panels	Anutone	Armstrong	Decosonic
GLAZINGS				
99	Anodised Aluminum Hardware (Heavy Duty)	Hardima	Alualpha	LGF Sysmac
		Everite	Godrej	
100	Aluminum Structural Members – Windows, Glazing and Partitions	Jindal	Indalco	Hindalco
		Nalco	Bhoruka	
101	Aluminum Sheet roofing Top 0.9mm thick AA 3004 aluminium alloy and 2nd layer Bare Galvalume sheet, 0.5 mm TCT	KalZip	Tata BlueScope	
102	Pre-coated Galvanised Steel Sheet	Tata BlueScope	Llyod Insulations India Ltd	/ S.R.Metals
		Interarch		
103	Glazing Structural / Suspanded /Skylight	Saint Gobain	Pilkington	Glaverbal
104	Clear / Float / Frosted Glass / Mirror	Saint Gobain	AIS	Pilkington
		MODI Guard	Atul	
105	Fire Rated Glass	Saint Gobin	Schott	
106	Glass Spider Fittings	Dorma	HAFALE	OZONE
107	Stainless Steel Railing, Accessories etc in Grade SS OR 316	Dorma	D-line	Geze
		Ozone	Q-railing	
108	Fire rated vision Panels	Pilkington	SCHOTT	FERILITE
		Saint Gobain	Glaverbel	
109	Ceramic panel Cladding	Hunter Douglas	Neolith	Terreal
110	Aluminum Louvers	Lindner	Chicago Metals	Colt
		Hunter Douglas	Kawneer	Faveton
111	Aluminium composite Panels	Aludecor	Alstrong	Durabuild
112	G. I Steel door frame/Pressed Steel Door frame	Synergy Thrislington	Navair	Shakti
113	Friction Stay Hinges	Dorma	LG Sysmac	Dorset

114	EPDM Gasket	Hanu	Anand	Osaka / Alps
		Anand Reddiplex	Enviro Seals	
115	Mirror Glass	Asahi India Safety Glass Ltd	Modi Guard	Saint Gobain
116	UPVC Doors & Windows	Fenesta	Veka	Aluplast
		LG Hausys		
117	Nuts / Bolts & Screws	GKW	Atul	Hilti
118	Door / Window Fittings	Godrej	Ozone	Doorset
		Dorma		
119	Door Closer	Godrej	Ozone	Doorset
		Dorma		
120	Die Cast Patch Fittings	Dorma	Geze	Ozone
		Hettich	Hardwyn	
121	Fire rated doors &itshardwares	Navair	Shakti	Promat
		Harmann Shakti	Sukriti	
122	Floor Springs	Godrej	Ozone	Doorset
		Dorma		
123	SS Mortise lock with one dead bolt and pair of SS handles steel grade – SS304	Godrej	Ozone	Doorset
		Dorma		
124	Grab bars and Disabled Hardware	Dorma	Ozone	D-line
125	SS Mortise latch & lock with six levers and pair off SS handles steel grade – SS304	Godrej	Ozone	Doorset
		Dorma		
126	SS Tower bolt	Godrej	Ozone	Doorset
		Dorma		
127	SS Butt hinges with ball bearing grade – SS304	Godrej	Ozone	Doorset
		Dorma		
128	Magic Eye	Dorma	Godrej	Ingersoll Rand
129	Stainless Steel sliding door blots	Godrej	Ozone	Doorset
		Dorma		
130	Pull handle back to back of length 150mm of steel Grade-SS304	Godrej	Ozone	Doorset
		Dorma		
131	Pull handle, single side of length150mm of steel Garde – SS304	Godrej	Ozone	Doorset
		Dorma		
132	Aluminium level handles	Hardima	Godrej	Everite
		Classic	EBCO	
133	Anodised Aluminium Hardware (Heavy Duty)	Hardima	Godrej	Everite
		Classic	EBCO	
134	Automation Systems for Windows	UCS	Window Master	Essmann
		Rivalu	Securistyle	
135	Lever handle in SS 304 finish	Godrej	Ozone	Doorset
		Dorma		
136	PVC Water Stops	BASF	Supreme	Oriplast

137	R.C.C Pipes	Indian Hume Pipe	Pragati Concrete Udyog	KK
		Daya		
138	Rolling shutter	Rama	Prakash	

PLUMBING WORKS

SANITARY FIXTURES & CP BRASS FITTINGS

1	Sanitary Fixtures	kOHLER	Hindware	Jaquar
2	CP Brass Fittings & Accessories	kOHLER	Hindware	Jaquar
3	Kitchen Sinks	Neelkanth	Jayna	Hindware
		Nirali		
4	Water Cooler	Blue Star	Usha	Voltas
		Eureka Forbes		
5	Electric Storage Type Geyser	Venus	AO Smith	Racold
6	Hand Drier	Euronics	Jaquar	Utec
7	RO Purifier Units	Kent	ION Exchange	AO Smith
		3M		

SOIL, WASTE, VENT & RAIN WATER PIPES

1	Hubless Centrifugally cast (spun) Iron pipes & Fittings SS 304 grade coupling with EPDM rubber gasket	Neco	Kapilansh	Hepco
2	GI Pipes	Jindal Hissar	Prakash Surya	Tata
3	GI Pipe Fittings	Zoloto M	DRP	New
		Unik		
4	GI clamps with EPDM rubber	Intellotech	Indotech	Hilti
		CAMRY		
5	Brass Clean Out Plugs	Neer	Vijay	GMGR
6	Stainless Steel Gratings	Chilly	Camry	Kamal
7	uPVC Pipes & Fittings	Ashirvad	Finolex	Astral
		AKG		

WATER SUPPLY SYSTEM

1	CPVC Pipes & Fittings	Ashirvad	/Finolex	/Astral
		AKG		
2	GI Pipes	Jindal Hissar	Prakash Surya	Tata
3	GI Pipe Fittings	Zoloto M	DRP	New
		Unik		
4	Water Meter	Kranti	Toshaniwal	Capstan
		Anand		

5	DI Pipes & Fittings	Electrosteel	Kesoram	Tisco
6	Forged Brass Ball Valves	Giacomini	Zoloto	Sant
		DRP	New	
7	CI Butterfly Valves	Zolato	Audco	Sant
		DRP		
8	Pipe Insulation	Armaflex	K-Flex	Thermaflex
		Kaiflex		
9	Motorised Valves	Zoloto	Sant	AIP
10	Single Acting Air Release Valve	Giacomini	Zoloto	Sant
		DRP		
11	Central RO Plant	Ion Exchange	Thermax	Pentair
		Eureka Forbes		
12	Polyethylene Storage Tank	Sintex	Supreme	Sheetal
HOT WATER SYSTEM (HEAT PUMP)				
1	Heat Pumps	AO Smith	Cristopia	Bluebox
		Climaveneta	Klima	
2	Hot Water Recirculation & Return Pumps	Willo	Grundfoss	KSB
		Xyllum		
SEWERAGE & DRAINAGE SYSTEM				
1	HDPE Double Wall Corrugated (DWC)	Finolex	Astral	Ashrivad
		Supreme		
2	SFRC Manhole Cover & Frame	KK Manholes	SK Precast Concrete	Advent concreteovision
3	Foot Rests	KJM	Deesawala	Surya
		Sinecos		
4	Grease Seperator	ACO	Kessel	Klaro
5	RCC Pipes	Jain Spun Pipes	Dewan Spun Pipes	Usha Spun Pipes
		KK Concrete Products		
WATER SUPPLY, BOREWELL, DRAINAGE PUMPS & WATER TREATMENT EQUIPMENTS				
1	Water Supply Pumps	Willo/	Grundfoss	KSB
		Xyllum		
2	Drainage Pumps	Willo	Grundfoss	KSB
		Xyllum		
3	Borewell Pumps	Willo	Grundfoss	KSB
		Crompton Greaves		
4	Hydropneumatic System	Willo	Grundfoss	KSB
		Xyllum		
5	Water Filters	Ion Exchange	Thermax	Pentair
6	Water Softeners	Ion Exchange	Thermax	Pentair
7	Chemical Dosers (Cholorinators)	Asia LMI	Toshcon	Chloromax
8	Electrical Panels	As per Electrical Make List		

9	GI Pipes	Jindal Hissar	Prakash Surya	Tata
10	GI Fittings	Zoloto M	DRP	New
		Unik		
11	CI Butterfly Valves	Zolato	Audco	Sant
		DRP		
12	CI Dual Plate Check Valves	Zolato	Audco	Sant
		DRP		
13	CI Strainers	Zolato	Audco	Sant
		DRP		
14	Vibration Eleminators/ Rubber Bellow	Resistoflex	D'wren	Kanwal
15	Electric Wires & Cables	As per Electrical Make List		
SEWAGE TREATMENT PLANT				
1.	Air Blowers	Beta	Everest	Kulkarni
		TMVT		
2.	Air Diffussion System	Airfin	Usha Ruba	Rehau
3.	Air Vent Valve	Oven trop (Germany)	CIM	Rapid Control
4.	Bar Screen	KSP	AWMS	PAMM
5.	Centrifuge	Apollo	United	B.A Engineering
6.	Chemical Cleaning Pump	WILO	Grundfos	Xylem
		KSB		
7.	Chemical Cleaning tank	Polycon	Sintex	Vectus
		Supreme		
8.	Electrical Panel	As per Electrical Make List		
9.	Flow Meter (Digital)	Aster (Totalized)	VATS	Scientific
10.	Flow Rota Meter for Suction Pump	UKL	Aster	Scientific
11.	Foot Valve	Sant	Zoloto	Advance
		DRP		
12.	G.I. fittings (malleable cast iron)	Unik	Zoloto	New
		DRP		
13.	Level Controller	Aster	Cirrus Engineering	Rockwell Automation
14.	Level Indicator	Aster	Cirrus Engineering	Rockwell Automation
15.	Level Switch	Aster	Cirrus Engineering	Rockwell Automation
16.	MBR Permeate Suction Pump	WILO	Grundfos	Xylem
		KSB		
17.	Media	Cooldeck	Usha Ruba	MM Aqua
		Pharmatech		
18.	Multiport Valve	Pharer (U.S.A)	ORG	Astar
19.	PH Meter	VATS	Hanna	Aster
		digital		

20.	PLC / HMI	Schneider	Allen bradley	Mitsubishi
21.	Semi Auto Fine Screen	Toro	KSP	AWMS
		PAMM		
22.	UV Systems	Alpha UV	Creative UV	Pentair
		Eureka Forbes		
23.	VFD	Danfoss	Allen Bredly	Siemens
		ABB		
24.	STP Vendors	B S Enviro	Degrimont	Thermax
		UEM	DOSHION	
FIRE FIGHTING SYSTEM				
1.	Gas Based Fire Suppression System	Safegaurd	Ceasfire Industries	Pyrogaurd Engineers
2.	Deluge valve/ Solenoid valve/ Spray nozzle/ Installation Control Valve	Victaulic	Smith Copper	Anvil
3.	Fire Pumps	Mather&Platt(WILO)	Grundfos	Kirloskar
		KSB		
4.	Fire Buckets	Safegaurd	Lifegaurd	Swastik
		Minimax		
5.	Fire Extinguishers	Safegaurd	Lifegaurd	Swastik
		Minimax		
6.	Fire Hydrant Valves/ Fire RRL Hose Pipes / Fire Hose Reels/ Fire Man's Axe/ short branch pipe/ 2/ 3/4 FB inlet/ draw Out connection/Hose Box/ Hose reel drum /Nozzle/ blank Caps & Chains / Coupling	Safegaurd	Lifegaurd	Swastik
		Minimax		
7.	Flow switch	Potter	Rapid flow	Danfoss
		Viking	Belimo	Honeywell
8.	Pipe coat material (pipe protection)	Pypcoat	Makphalt	
9.	Pipe Hangers/ Clamps/Supports	Chilly	GMGR	CAMRY
		Hilti		
10.	Mild Steel Pipes	Jindal Hissar	Prakash Surya	Tata
		SAIL		
11.	Weld Electrodes	Advani	ESAB	L&T
		Victor		
12.	Pressure Gauge	Fiebig	H.GURU	HD

		BRC		
13.	Push Buttons/ Indicating lamps LED	As per respective electrical make list		
14.	Single Phase Preventer	As per respective electrical make list		
15.	Solenoid valve/ Spray nozzle	HD	Tyco	Danfoss
		Honeywell		
16.	Sprinkler Heads (Sidewall/ Upright/ Pendant)	Grinnel- Tyco	Viking	HD
17.	Sprinkler Flexible Drops	Victaulic	Smith Copper	Anvil
18.	MS Forged Fittings	New	DRP	VS
		SS		
19.	Pop up Connecting Assembly	Rain Bird	Dura	Lasco
20.	Popup Spray Head	Rain Bird	Toro, USA	Nelson,
21.	Powder Coating Material pure Polyester	Jotun	Berger	Goodlass Nerolac
22.	RQRC Hydrant	Harvel	Alprene	Rain Bird, USA
23.	RQRC Key	Harvel	Aqua	Drip& Drip
24.	CI Butterfly Valves/Sluice Valves	Zolato	Audco	Sant
		DRP		
25.	CI Dual Plate Check Valves	Zolato	Audco	Sant
		DRP		
26.	CI Strainers	Zolato	Audco	Sant
		DRP		
27.	Vibration Eleminators/ Rubber Bellow	Resistoflex	D'wren	Kanwal
28.	Electric Wires & Cables	As per Electrical Make List		

ELECTRICAL WORKS				
1.	AIR CIRCUIT BREAKER (MODEL SHALL BE AS PER TENDER SPECIFICATION & BOQ)	SCHNEIDER (MVS)	L&T (U Power)	ABB (E-Max)
		SIEMENS (3WL)		
2.	MCCBS BREAKER (MODEL SHALL BE AS PER TENDER SPECIFICATION & BOQ)	SCHNEIDER (CVS)	L&T (D-Sine)	ABB (T-Max)
		SIEMENS (3VA)		
3.	SFU / FSU / HRC/ HBC FUSES & BASES	L&T	SIEMENS	SCHNEIDER
		ABB		
4.	MCB/ ELCB/ RCCB/ RCBOS/ DISTRIBUTION BOARDS (DOUBLE DOOR IP43 DBs)	LEGRAND EKINOXE3	HAGER NOVELLO	SIEMENS (BETA GUARD)
		SCHNEIDER ACTI-9	ABB	

5.	AUTOMATIC TRANSFER SWITCH/ CHANGE OVER SWITCH (OFF LOAD/ ON LOAD)	HPL	SOCOMEC	ASCO
		HAVELLS	ABB	
6.	METAL CLAD SHEET STEEL ENCLOUSER SOCKET/ PLUG BOX	L&T	SCHNEIDER	SIEMENS
		ABB	LEGRAND	
7.	LOAD BREAK SWITCHES	L&T	SIEMENS	SCHNEIDER
8.	FR/ FRLS/ XLPE LT CABLES & WIRES – ROHS COMPLIANCE (ARMOURED OR OTHERWISE)	POLYCAB	FINOLEX	BONTON
		HAVELLS		
9.	MODULAR PLATE SWITCHES AND SOCKETS	LEGRAND (Arteor)	SCHNEIDER (OPAL)	MK (Blenz)
		WIPRO (North west)		
10.	TRIVECTOR METER/ AMP METER/ VOLT METER / ENERGY METER/ MFM	NEPTUNE	SECURE	CONZERV
		TRINITY	SOCOMEC	
11.	TELECOMMUNICATION / TV CABLE	FINOLEX	POLYCAB	BONTON
		HAVELLS		
12.	MAIN LT PANEL/ APFC PANELS (TTA IS:8623-1)	TRICOLITE	L&T	CONQUERENT SCHNEIDER
		SIEMENS	ABB	
13.	BUSBAR	GINDAL	HINDALCO	CENTURY
14.	PVC CONDUIT/ FLEXIBLE CONDUIT & ACCESSORIES (ISI MARKED)	BEC	AKG	POLYCAB
15.	STEEL CONDUIT/ FLEXIBLE & ACCESSORIES (ERW) (ISI MARKED)	RM CON	BEC	NIC
		MKAY		
16.	LT PANEL/ PCC/ MCC/ MCBS/ DG SYNCHRONIZING PANELS/ PANELS/ CONTROL PANELS/ FEEDER PILLARS/ SERVICE PILLAR / H.T. PANEL	TRICOLITE	CONQUERENT	ADLEC
		SPC ELECTROTECH		
17.		1) PANEL MANUFACTURER MAKE APPROVAL SHALL BE TAKEN BY ARCHITECT / CONSULTANT/UNIT INCHARGE BEFORE ORDER THE PANEL.		

		2) FABRICATION FACILITY UP TO IP 54/55.		
		3) 9 TANK PRE TREATMENT FACILITIES FOR SHEET.		
		4) EQUIPPED WITH LATEST CNC BENDING, POWDER COATING, BUS BAR BENDING & PUNCHING MACHINE, AND COMPRESSOR ETC.		
18.	SANDWITCH BUSDUCT (F CLASS)	SCHNEIDER	L & T	FEDERAL & GERSAN
		EAE Turkey	SUPERBAR	
19.	FR/ FRLS/ XLPE HT CABLES – ROHS COMPLIANCE (ARMOURED OR OTHERWISE)	POLYCAB	FINOLEX	HAVELLS
20.	BAKELITE SHEET	HYLAM	FORMICA	GREENLAM
21.	VOLTAGE TRANSFORMERS	SIEMENS	L&T	KAPPA
		PEPL	ABB	
22.	CURRENT TRANSFORMER	SIEMENS	L&T	KAPPA
		PEPL	ABB	
23.	CEILING FAN/ EXHAUST FAN (BLDC)	CROMPTON	BAJAJ	USHA
		HAVELS	ORIENT	
24.	TAG BLOCK	KRONE	ERICSON	TVAR&M
25.	TRANSFORMERS	VOLTAMP	TMC TRANSFORMER	CROMPTON
		KIRLOSKAR	ABB	SCHNEIDER
26.	AUTOMATION POWER FACTOR CONTROL RELAY	L&T	SIEMENS	SCHNEIDER
		ABB		
27.	CAPACITORS &REACTORS	L&T	SIEMENS	SCHNEIDER
		ABB		
28.	CABLE GLANDS (DOUBLE COMPRESSION WITH EARTHING LINKS)	DOWELLS	COMET	GRIPWELL
29.	BI-METALLIC CABLES LUGS/ PVC GLANDS	DOWELLS	ACTION	JAINSONS
		KABEL		
30.	CABLE JOINTING KITS	RAYCHEM	JAINSONS	3M
		DENSONS		
31.	CABLE TRAYS (FACTORY FABRICATED) / RACEWAYS (G.I.)	INDIANA	CTM ENGINEERS	MEM
		KAMBOJ ELECTRO CONTROL		
32.	BATTERY (SEALED MAINTENANCE FREE)	AMCO	EXIDE	AMARA RAJA
33.	BATTERY CHARGER	AMARA RAJA	CHHABI ELECTRIC	CROMPTON GREAVES
34.	DG SET	CATERPILLAR	CUMMINS	MTU
		MITSUBISHI	VOLVO PENTA	PERKINS
35.	DG SET ALTERNATOR	STAMFORD	LERROY	KIRLOSKAR

			SOMMER	
36.	CONTROL GEAR (CONTRACTORS ETC.)	L&T	SIEMENS	SCHNEIDER
		ABB		
37.	PROTECTION RELAYS MICROPROCESSER BASED	AREVA	L&T	ABB
		SIEMENS	SCHNEIDER	
38.	EARTH LEAKAGE RELAY	L&T	PIC	MINILEC
		EATON		
39.	SINGLE PHASING DEVICE	L&T	SIEMENS	MINILEC
40.	PUSH BUTTONS	L&T	SIEMENS	SCHNEIDER
		ABB		
41.	TIME RELAY DEVICE	L&T	SIEMENS	SCHNEIDER
		ABB		
42.	SELECTOR SWITCHES & ROTARY SWITCHES	L&T	SIEMENS	SCHNEIDER
		ABB		
43.	INDICATING LIGHTS	L&T	SIEMENS	SCHNEIDER
		ABB		
44.	TERMINALS	ELMEX	ESSEN	DEINKI
		WAGO		
45.	TELEPHONE OUTLETS	AS PER SWITCH / SOCKET MAKE.		
46.	MOTORS	ABB	CROMPTON	SIEMENS
		KIRLOSKAR	BHARAT BIJLI	
47.	IPBAX & TELEPHONE SYSTEM	SIEMENS	ERICSSON	ALCATEL-LUCENT
		MITEL		
48.	MULTI-METER & MEGGARS	ESCROP	MOTWANI OR EQUIVALENT	
49.	PROGRAMMABLE LOGIC CONTROLLER	SIEMENS	WOODWARD	ALLEN BRADLEY
50.	EARTHING / LIGHTNING PROTECTION UNIT	JMV	ERICO	LPI
51.	UPS	APC SCHNEIDER	EMERSON	TATA LIBERT
		3EM	EATON POWER	AUTOMETERS ALLIANCE LTD.
52.	FIRE ALARM SYSTEM (All COMPONENTS SHALL BE UL LISTED & CONFIRM TO NFPA STANDARD)	NOTIFIER	IFC	NOHMI
		BOSCH	ADVANCED	
53.	PA SYSTEM	NOTIFIER	IFC	NOHMI
		BOSCH		
54.	PUMPS	WILLO	KIRLOSKAR	KSB

		XYLLUM		
55.	LT SERVO AUTOMATIC VOLTAGE STABILIZER	AE	LOGICSTAT	LD POWER TRANSFORMERS (PVT.)LTD.
56.	D.G. SET ACCOUSTIC ENCLOSURE	AS PER D.G. SUPPLIER AND APPROVED BY OEM AND CONSULTANT / ARCHITECT.		
57.	M.S. PIPE	TATA	JINDAL HISSAR	SAIL
		PRAKSH SURYA		
58.	BUTTERFLY / BALANCING VALVE	ZOLOTO	AUDCO	SANT
		DRP		
59.	POT STRAINER / Y STRAINER	ZOLOTO	EMERALD	SANT
		DRP		
60.	CCTV CAMERA / DVR / NVR	HONEYWELL	SONY	BOSCH
61.	ACCESS CONTROL	BOSCH	TYCO	LENEL
62.	CAT 6A	CISCO	D-LINK	NETGEAR
63.	MINERAL INSULATED COPPER CABLE	TYCO	ROCKBESTOS	MICC
		CAVICEL		
64.	FIRE SUPPRESSION SYSTEM	MINIMAX	UTC	FIRETRACE
65.	VIBRATOR ELIMINATOR	KANWAL	RESISTROFLEX	D'WREN
66.	INSULATION	UP TWIGA	KIMCO	LLYOD
67.	WELD ELECTRODES	ADVANI	ESAB	L&T
		VICTOR		
68.	BOOM BARRIER	FAAC	GODREJ VIGIGUARD	SOMFY
		GUNNEBO		
69.	DWC HDPE PIPE	FINOLEX	ASTRAL	ASHIRVAD
		SUPREME		
70.	INVERTER	MICROTEK	LUMINOUS	SU-KAM
71.	SEMI ROTARY TYPE HAND FUEL FILLING PUMP	ROTODEL	KITTY	GROZ
72.	SOLAR PV MODULE	ADANI	VIKRAM	TATA
73.	SOLAR INVERTER	DELTA	NEOWATT	SCHNEIDER
74.	DC CABLE	POLYCAB	HAVELLS	FINOLEX
75.	LIGHT FIXTURES (LED)	LEGERO	WIPRO	HAVELLS
		INSTA POWER		
76.	EXTERNAL LIGHTING POLE	VALMONT	NERI	GLOWMAG
77.	LANDSCAPE / FACADE AREA LIGHT	LVELA	ES SYSTEM	LITOLUX
78.	STREET LIGHT	CARIBONI	EWO	HEPER
		INSTA POWER		
79.	HENSEL BOX	HEPER	ES SYSTEM	LITOLUX

80.	MC4 CONNECTOR	SYNERGY	SETLLAR	SCHNEIDER
81.	ALL POWER AMPLIFIERS	BOSE	POWERSOFT	ELECTRO VOICE
		BOSCH		
82.	ALL LOUDSPEAKERS, LINE ARRAYS AND SUBWOOFERS IN CLASS ROOMS AND AUDITORIUMS	BOSE	MARTIN AUDIO	D&B AUDIOTECHNIC
		BOSCH	ELECTRO VOICE	
83.	CEILING SPEAKER (AUDIO/ VIDEO)	BOSE	MARTIN AUDIO	D&B AUDIOTECHNIC
		BOSCH	ELECTRO VOICE	
84.	STAGE LIGHTING	CANARA LIGHTING	MARTIN LIGHTS	ROBE
85.	NETWORK SWITCH	CISCO	D-LINK	NETGEAR
86.	ALL SWITCHING & CONTORLS, RECEIVERS, TRANSMITTERS, SCALER EXTENDER	BOSCH	CRESTRON	EXTRON
87.	PROJECTOR	BARCO	CHRISTIE	DIGITAL PROJECTION
88.	ELEVATORS	TOSHIBA	OTIS	MITSUBISHI
		SCHINDLER	KONE	
89.	MOTORIIZED SCREEN IN CLASS ROOMS AND AUDITORIUMS	DALITE	DRAPER	SUVIRA
90.	FLAT PANAL DISPLAY	CHRISTIE	NEC	PLANAR
91.	DOCUMENT CAMERA	ELMO	LUMENS	WOLF VISION
92.	HIGH DEFINITION VIDEO CONFERENCING	CISCO	POLYCOM	SONY
93.	CAMERA SECONDARY	LUMENS	POLYCOM	SONY
94.	MULTI FORMAT PRESENTATION SWITCHER WITH CONTROL PROCESSOR IN CLASS ROOMS AND AUDITORIUMS	AMX	CRESTRON	EXTRON
		BOSCH		
95.	WIRELESS TOUCH PANEL WITH ACCESSORIES IN CLASS ROOMS AND AUDITORIUMS	AMX	CRESTRON	EXTRON
		BOSCH		
96.	CONFERENCE SYSTEM IN CLASS ROOMS AND AUDITORIUMS	BEYERDYANMIC	BRAHLER	MARCONI TECHNOLOGIES
		BOSCH	SCHINDLER	
97.	DELEGATE AND CHAIRMAN MICROPHONES	BEYERDYANMIC	BRAHLER	MARCONI TECHNOLOGIES
		BOSCH		

98.	HANDHELD AND LAPEL MICROPHONES	BEYERDYANMIC	BRAHLER	MARCONI TECHNOLOGIES
		BOSCH		
99.	DIGITAL SIGNAL PROCESSOR	CRESTON	BOSE	BIAMP
		BOSCH	BRAHLER	
100.	VGA WITH AUDIO PATCH CABLE	AMX	CRESTRON	EXTRON
		KREMER		
101.	HDMI PATCH CABLES	AMX	CRESTRON	EXTRON
		KREMER		
102.	DIGITAL VIDEO CABLE NON-PLENUM	AMX	CRESTRON	EXTRON
		KREMER		
103.	CONTROL CABLE	BELDEN	CRESTRON	EXTRON
104.	MICROPHONE CABLE	AMX	CRESTRON	EXTRON
		KRYSTAL	BELDEN	
105.	AUDIO AND STEREO CONTROL CABLE	BELDEN	CRESTRON	EXTRON
		KRYSTAL		
106.	SHIELED CHIELDED CAT 6A / FIBRE CABLE	CISCO	D-LINK	NETGEAR
107.	BULK CONNECTORS	NEUTRIK	SWITCHCRAFT	AMPHENOL
108.	EQUIPMENT RACH	CHIEF	MIDDLE ATLANTICA	VALRACK
109.	LIGHTING CONTROLLER/ MANAGEMENT SYSTEM	LUTRON	ZUMTOBEL	HONEYWELL
110.	SMART PODIUM	UNI	AHA	TECOMM
		LUMIN	PEOPLE LINK	
111.	INTERATIVE WHITE BOARD	PROMETHEAN	HITE VISION	SMART
112.	COUNTDOWN CLOCK	BIGTIME CLOCKS	ULTRAK	BANGGOOD
113.	COMPUTER	HP	DELL	IBM
114.	MONITOR	SAMSUNG	PANASONIC	LG
		DELTA	CRISTLE	
115.	12 BAY NAS	NETGEAR/CISCO	DELL	HP
116.	10 G CORE SWITCH	NETGEAR/CISCO	DELL	HP
117.	L3 POE PLUS SWITCH	NETGEAR/CISCO	DELL	HP
118.	DUAL BAND 11 AC ACCESS POINT	NETGEAR/CISCO	DELL	HP
119.	10G SINGLE MODE SFP+ MODULE	NETGEAR/CISCO	DELL	HP
120.	SECURE NETWORK SERVER	CISCO	DELL	HP
HVAC SYSTEM WORKS				

CHILLERS				
1.	Water Cooled Centrifugal Chillers With VSD (AHRI Certified)	Carrier	Daikin	Trane
		Jhonson		
2.	Rotary Screw Water-cooled Water Chilling Machine (AHRI Certified – 200 TR & Above)	Carrier	Daikin	Trane
		Jhonson		
3.	VRV / VRF System (Outdoor / Indoor Units, Copper Y Joints and Fittings, Central & Remote Controller)	Daikin	Toshiba	Mitsubishi
		O General		
4.	Air-cooled Ductable Split Unit	Daikin	Hitachi	Carrier
5.	Air-cooled Packaged Unit	Daikin	Hitachi	Carrier
6.	Air Cooled Hi-wall / Cassette Unit	Daikin	Hitachi	Carrier
7.	Air Cooled Precision AC Unit	Emerson	APC	Stulz
		Blue Box		
8.	Horizontal Split Casing / Vertical Inline / End Suction / Monoblock Pump Sets (For Primary CHW Pumps & Condenser Water Pumps & Hot Water Pumps)	ITT Xylem	Armstrong	Grundfoss
9.	Variable Speed Pumping System (For Secondary Chilled Water Pumps Motors)	ITT Xylem	Armstrong	Grundfoss
10.	Variable Frequency Drive (For Pumps, Cooling Tower & AHU)	Danfoss (FC 102)	ABB (ACH 550)	Siemens (Sinamics G120P)
		VTS		
11.	Expansion Tank	Xylem-ITT	Armstrong	Grundfos
		Anergy		
12.	Cooling Tower (CTI/JCI Approved & Certified)	Paharpur	DVR	Advance
		Bell		
13.	Air & Dirt Separator, Automatic Air Vent, Vacuum Degasser	Spirotech	Spirotherm	Anergy
		Caleffi		
14.	Hot Water Generator & Pan Humidifier	KEPL	Emerald	Rapid Cool
15.	Electrochemical Water Treatment & Disinfection System (For AC Plant)	Elgressy	Terragon	ENPAR Technologies
16.	Air Handlers Unit	VTS	Waves	Ravi Aircon
		Edgetech		
17.	Fan Coil Unit	VTS	Waves	Ravi Aircon
		Edgetech		
18.	AHU Fans (AMCA Certified for Sound & Performance)	Krugger	Wolter	Nicotra
		VTS		

19.	Heat / Energy Recovery Wheel	DRI	Greenheck	Enventus
20.	Air-washer & Wet Scrubber	VTS	Waves	Ravi Aircon
		Edgetech		
21.	Dry Scrubber	Trion	Rydair	
22.	Scrubber & Air-washer Fans (AMCA Certified for Sound & Performance)	Krugger	Wolter	Nicotra
23.	Acoustically Insulated Box Type Inline Fans	Ostberg	Krugger	Wolter
		Airflow		
24.	Axial Fan / Centrifugal Fan (AMCA Certified for Sound & Performance)	Greenheck	Airflow	Krugger
		Wolter		
25.	Propeller Fan	GE	Usha	Bajaj
26.	Three phase motors	ABB	CG	Siemens
		Marathon		
27.	Three phase motors (250°C for 2 Hours)	Marathon	Havells-Lafert	Baldor
28.	Water Piping Upto 150mm dia	Tata	SAIL	Jindal Hissar
		Prakash Surya		
29.	Water Piping Above 150mm dia	Tata	MSL	Jindal
		Prakash Surya		
30.	Y-strainer / Pot – strainer	Emerald	Sant	Rapid Cool
		Zoloto		
31.	Butterfly Valve (Manual & Motorized)	Advance	DRP	Zoloto
		Leader		
32.	Actuator for Motorised Butterfly Valve	Belimo	Siemens	Danfoss
		Honeywell		
33.	Manual Balancing Valve	Advance	Zoloto	Leader
34.	Dual Plate Check Valve	Advance	Zoloto	Leader
35.	FCU Valve Station	Calefi	CNM	ATS
36.	Pressure Independant Control cum Balancing Valves / High Rangebility Valve	DANFOSS	JOHNSON CONTROL	SIEMENS
		ANERGY		
37.	Thermostat / Humidistat	DANFOSS	JOHNSON CONTROL	SIEMENS
		ANERGY		
38.	Globe / Ball Valve (With or Without Strainer)	Advance	AIP	Zoloto
		Leader		
39.	Auto Air Vent Valve	Calefi	Spirotech	Anergy
40.	Pressure Gauges	Feibig	Emerald	H Guru
		Taylor		
41.	Industrial Type Thermometer (Alcohal filled V form)	Feibig	Emerald	H Guru
		Taylor		

42.	GSS Sheet	Sail	Tata	Jindal
43.	Factory Fabricated Duct	Zeco	Ductofab	Waves
		Projtech		
44.	Aluminium Sheet	Hindalco	Balco	Nalco
45.	Vibration Isolation Spring & Flexible Pipe Connector	Easyflex	Resistoflex	Dunlop
		Kanwal		
46.	VAV Boxes	Titus	Cynor	Johnson
		Glenstrom		
47.	CAV	Cynor	Trox	Glenstrom
48.	Fire & Smoke Damper	System Air	Cynor	Glenstrom
		Titus		
49.	Fire Damper Actuator	Belimo	Siemens	Honeywell
50.	Extruded aluminum grills / Diffusers	System Air	Cynor	Glenstrom
		Titus		
51.	Pre Filters, Fine Filters & Hepa Filters	Thermodyne	Spectrum	Mechmark
52.	Closed Cell Fire Retardant XPE (For Duct Insulation)	Paramount	Supreme	Trocyllene
53.	Nitrile Rubber For Pipe / Duct Insulation (With Mechanical & UV Protection)	Armacell	Supreme	Kflex
		ALP Aeroflex		
54.	V Belt	Dunlop	Fenner	Hilton
55.	Fibre Glass Rigid Board	U.P.Twiga	Owen corning	Kimco
56.	Paints	ICI	Asian	Berger
		Nerolac		
57.	Tar felt / CPRX compound	Shalimar tar product		
58.	Dash Fasteners	Fisher	Hilti	Bosch
59.	Welding Rods	Advani	L&T	Esab
60.	Insulated Flexible Duct	Atco	Caryaire	Cynor
61.	Duct / Pipe Support	Easyflex	Gripple	Resistoflex
		Hilti		
62.	Copper Refrigerant Piping	Mandev	Rajco	Shree Shyam
		Mexflow		
63.	Copper Refrigerant Pipe Insulation	Armacell	ALP Aeroflex	Kflex
		Supreme		
64.	Duct Mounted Bio-polar Ionization System	Ruks	Trimed	Plasma Air
65.	Imported AHU UVC / CoiloTron / UVGI	Ruks	Trimed	Pureair
66.	Heater Bank	Das Pass	Escorts	KEPL
67.	UV & Weather protective Coating	Pidilite	Foster	Amicon
68.	Magnehelic Gauges	Mitbraus Instruments	Dwyer	Omicron

69.	Electrical Panel, Console Panel & Sub-Panels	As per Electrical make		
70.	Air-Circuit Breaker	As per Electrical make		
71.	M.C.C.B.	As per Electrical make		
72.	MCB	As per Electrical make		
73.	Starters, Contactors, Push Buttons, Overload Relay	As per Electrical make		
74.	Single Phase Preventer	As per Electrical make		
75.	Current Transformer	As per Electrical make		
76.	Rotary Switches	As per Electrical make		
77.	Change Over Switch	As per Electrical make		
78.	Voltmeter / Ammeter	As per Electrical make		
79.	Indicating Lamps	As per Electrical make		
80.	Time Delay Device	As per Electrical make		
81.	Control Cable & Accessories	As per Electrical make		
82.	MS Conduits ISI Approved	As per Electrical make		
83.	TDRs	LT-LK	BCH	
84.	GI Cable Tray (Factory Fabricated)	As per Electrical make		
85.	Vacuum Degasser	Spirotech	Comfort	Spirotherm
86.	BMS System			
87.	Software	Honeywell-Webs	ALC	ABB
88.	Network Area Controller	Honeywell-Webs	ALC	ABB
89.	Third Party Integrator	Honeywell-Webs	ALC	ABB
90.	Central and DDC Controllers	Honeywell-Webs	ALC	ABB
91.	Ultrasonic BTU / Flow Meters	Forbes Marshall	Landis & Gyr	Fuji
		Omicron		
92.	Immersion Temperature Sensor	Honeywell	ALC	ABB
		Omicron		
93.	Return Air Temperature Sensor	Honeywell	ALC	ABB
		Omicron		
94.	Network / Remote Operator Terminal	Honeywell	ALC	ABB
95.	Smoke Sensor	Honeywell	ALC	ABB
		Omicron		
96.	Temperature plus RH Sensor	Honeywell	ALC	ABB
		Omicron		
97.	Differential Pressure Switch-Air	Honeywell	ALC	ABB
		Omicron		
98.	Differential Pressure Switch-Water	Honeywell	ALC	ABB
		Omicron		
99.	Computer	IBM	HP	Dell

100.	Laser Printer	HP	Sharp	Canon
101.	CAT-6 Cable	Molex	Fusion Polymer	belden
		R&M		
102.	Signal Cable	Polycab	Skytone	Versha
103.	CO2 Sensor	Honeywell	Omicron	Vishala
104.	CO Sensor (Electro Chemical Gel Based)	Honeywell	Omicron	Vishala
105.	Level Switch	Honeywell	Omicron	Vishala
106.	Current Relay	Honeywell	Omicron	Vishala
107.	DC Voltage Transducer	ABB	Honeywell	Seto
		Mosibus		
108.	Multifunction Meter with Communication Port	As per Electrical make		
109.	Lux Level Sensor	Honeywell	ALC	ABB
		Omicron		
110.	Differential Pressure Transmitter-Air	Honeywell	ALC	ABB
		Omicron		
111.	Pressure Transmitter-Water	Honeywell	ALC	ABB
		Omicron		
112.	Digital Thermostat / Humidistat	Honeywell	ALC	ABB
		Omicron		
113.	Any Missing Item	Prior Permission is required from HVAC Consultant		

NOTE : All makes shall further confirm to standard specifications of each items as mentioned in technical specifications of tender documents.

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